

4.0

AFFECTED ENVIRONMENT

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4.1 Introduction

This section describes current conditions of the resources that may be affected by implementing the proposed action or its alternatives. The affected environment is defined as that portion of the physical, biological, and social environment that may be affected by implementation of the alternatives. The proposed action addresses 14 threatened salmonid ESUs. Any effects of the proposed action would occur within the ESU ranges, although some secondary effects may occur outside of these ranges. The analysis area consists of an area of 121,300 square miles in Washington, Oregon, Idaho, and California, including upland, freshwater, estuarine, and near-shore marine areas (Figure 1). The near-shore marine area extends 3 miles west of the coastline from the Puget Sound in Washington south to San Luis Obispo, California.

4.1.1 Environmental Setting

The analysis area spans four major physiographic provinces (Figure 2). The northern portion of the analysis area extends from the Northern Rocky Mountains of eastern Idaho and crosses the Columbia Plateau, Cascade Mountains, and the Pacific Border spanning Washington, Oregon, and Idaho. In Washington and Oregon, the analysis area consists of the Columbia River basin downstream of Priest Rapids Dam, all coastal watersheds between the Elk River in the south and the Columbia River in the north, and watersheds that drain to Puget Sound. In Idaho, the analysis area consists of the Snake River basin. In California, the analysis area lies within the confines of the Cascade-Sierra Mountains and the Pacific Border physiographic provinces. This area consists of the Sacramento Valley, the northern San Joaquin Valley, and all coastal watersheds from the Santa Maria River in the south to the Russian River in the north and including the Salinas Valley.

The analysis area consists of a varied landscape with heavily populated areas as well as many relatively undeveloped areas of scenic value. Forests and mountains in the Pacific Northwest and California generally have abundant and diverse aquatic, terrestrial, and wildlife resources. Water-related settings range from urban development and waterfront parks to wilderness mountain lakes and streams. A variety of Federal, state, and private land ownership patterns; different land productivity; and varying abundance of water influence land use in the analysis area. Large areas of publicly owned land provide a notable proportion of the natural and recreational resources found in the analysis area. As one looks to California, the proportion of land in private ownership increases considerably.

Population growth in the analysis area has occurred primarily in major metropolitan areas, such as Seattle, Tacoma, and Vancouver in Washington; Portland, Oregon; Boise, Idaho; and the San Francisco Bay area in California. The remaining areas are relatively sparsely populated because large tracts of land are devoted to agriculture, forestry, and livestock grazing.

Figure 1. Analysis Area: Geographic Extent of ESUs in July 2000 4(d) Rule

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Figure 2. Physiographic Provinces of Washington, Idaho, Oregon, and California

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Fifteen resources and other topics are described in this section:

1. Land Use (subsection 4.2)
2. Geology (subsection 4.3)
3. Soils (subsection 4.4)
4. Climate (subsection 4.5)
5. Air Quality (subsection 4.6)
6. Water Quantity (subsection 4.7)
7. Water Quality (subsection 4.8)
8. Fish and Wildlife (subsection 4.9)
9. Vegetation (subsection 4.10)
10. Demographic Trends (subsection 4.11)
11. Economy (subsection 4.12)
12. Recreation (subsection 4.13)
13. Cultural Resources (subsection 4.14)
14. Tribal Treaty and Trust Responsibilities; Tribal Rights and Interests (subsection 4.15)
15. Environmental Justice (subsection 4.16)

4.2 Land Use Categories

The analysis area encompasses Federal, county, municipal, state, tribal, and privately owned lands with a wide range of land uses (Figure 3). The variety of land uses in the analysis area includes forestry, agriculture, park and recreation, industrial (rural and urban), transportation (roads, rail, airports), and typical urban uses (including office, commercial, public facility, and residential). In Washington, land use is predominately agricultural and urban with some forest land located in the Cascade and Coastal Ranges. In Oregon, land uses are predominately forest and agricultural with heavily urbanized areas in the Willamette Valley, some in Central Oregon, and forest in the Cascade and Coastal Ranges. In Idaho, the primary land use type is Federal lands (National Park and National Forest) with some agriculture along the northern edge and in the southwest corner of the state. The urban area is primarily centered around Boise. In California, the land use type in the analysis area is generally urban in the San Francisco Bay metropolitan areas with agricultural uses scattered throughout the Sacramento-San Joaquin Delta. Forestry activities are also carried out in the northern and western parts of the analysis area in California.

While land ownership does not exclusively determine land use, it can drive land management activities. Land uses such as forestry, agriculture, and mining can occur on privately and publicly owned land. However, how these uses are managed is often determined by the type of land ownership. Other land uses, such as urban land uses, are most often correlated with privately owned land. Roadways and other public facilities are usually publicly owned by state or county and local jurisdictions. Over 60 percent of the land in the United States is privately owned. The Federal government is the next largest landowner with more than 28 percent,

Figure 3. General Land Uses

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mostly in the western United States (Vesterby and Krupa 1997). Forty-one percent of the Federal land is in the mountain region, which includes Idaho, and 14 percent in the Pacific region, including California. There is a large percentage of land under Federal ownership in Washington, Oregon, and Idaho. The majority of land in California is privately owned.

Land use is also driven by state, county, and local jurisdiction land use goals, policies, and laws. As an example, Oregon's land use laws provide statewide goals that are then implemented through comprehensive planning and zoning at the local level.

4.2.1 Agriculture

Agricultural activities occur throughout the analysis area. Grassland and other pasture and range lands for the four states have the highest area of agricultural land use compared to crop land pasture or grazed forest land (Table 2). For example, agriculture plays a major role within the Columbia and Snake Rivers' systems where it is the largest consumptive use of water. In addition to direct diversion of natural flows, agricultural water is supported by water storage in Federal and private reservoirs (subsection 4.7, Water Quantity).

Table 2. 1997 Pasture and Range land by state.

State	Crop Land Pasture (1,000 acres)	Grassland and other Pasture and Range (1,000 acres)	Forest Land Grazed (1,000 acres)	TOTAL (1,000 acres)
Washington	528	7,406	3,292	11,226
Oregon	919	22,395	11,699	35,013
Idaho	816	21,165	4,432	26,413
California	1,246	22,343	11,761	35,350

Source: Vesterby and Krupa 1997.

There has been some increase in agricultural land uses, as indicated by a growth trend in irrigated land for farms between the years of 1949 and 1997 (Table 3).

Table 3. Comparison of irrigated land area by state.

State	Year – 1949 (1,000 acres)	Year – 1997 (1,000 acres)
Washington	589	1,705
Oregon	1,307	1,949
Idaho	2,137	3,494
California	6,438	8,713

Source: U.S. Department of Agriculture 1997.

The rate of land development in the analysis area far exceeds the rate of population growth. The result of this development has been generally sprawling residential, commercial, and industrial development, often occurring on agricultural land (American Planning Association 1999). The conversion of agricultural land to urban type land uses is expected to continue as the population continues to grow.

4.2.2 Timber Harvest

According to the U.S. Forest Service, "...forest land is land that is at least 10 percent stocked by trees of any size, including land that formerly had tree cover and that will be naturally or artificially regenerated" (Table 4) (Vesterby and Krupa 1997). Activities within this land use category include timber harvests, road construction of non-paved roads, and recreational activities such as hiking, camping, and skiing.

Table 4. Forest land by major class, by state, in 1997.

	Timberland			Reserved timberland and other forest land**	Total forest land		
<i>State</i>	<i>Federal</i>	<i>Non- Federal</i>	<i>Total*</i>		<i>Federal</i>	<i>Non- Federal</i>	<i>Total</i>
Washington	6,209	11,209	17,418	4,473	9,540	12,351	21,891
Oregon	14,218	9,531	23,749	5,972	17,822	11,899	29,721
Idaho	12,895	4,227	17,122	4,815	17,356	4,581	21,937
California	10,319	7,634	17,953	20,594	20,655	17,892	38,547

Source: Vesterby and Krupa 1997.

*Distributions may not add to totals due to rounding.

**Includes 105 million acres of forest land in parks, wildlife areas, and other special uses.

Forest practices have changed over time. For example, in Oregon, forest land available for commercial timber management has been reduced substantially, resulting in decreased timber harvests. For example, 9 billion board feet were harvested from Oregon forest lands in 1971. By 1999, this figure had declined to 3.5 billion board feet. Much of this is due to dramatic decreases in timber harvest on Federal land, which fell from 5.5 billion board feet harvested in 1972 to 383 million board feet in 1999 (Oregon Blue Book 2002). Timber harvesting on privately owned commercial forest lands has also declined, from 3.1 billion board feet in 1971 to 2.7 billion board feet in 1999. The only increase in timber harvesting by land ownership occurred among private non-industrial forest landowners. In 1981, private non-industrial landowners harvested 180 million board feet; in 1999, this same group harvested 459 million board feet of commercial timber (Oregon Blue Book 2002).

4.2.3 Parks and Recreation

There are numerous areas of recreational land use in the four states including state and national parks, privately owned and developed recreational facilities, and privately developed and operated facilities on Federal forests. Recreational activities include a wide range of winter and summer activities (Table 5). Many of these recreational activities occur in forested areas, including developed recreational facilities (camping, skiing, resort uses), dispersed recreational activities (hiking and walking, pleasure driving, fishing, nature study), and wilderness experiences (hiking, camping, viewing scenery). In conjunction with the development of new or expanded recreational uses, expansion or development of road networks and auxiliary uses such as housing and services also occurs. Table 5 summarizes an example of this use in the analysis area.

Table 5. Estimated recreational use of public lands administered by the U.S. Bureau of Land Management by major activity grouping (fiscal year 1996).

Visitor Use Activities	Number of Participants (thousands)	Visitor Hours (thousands)	Visitor Days (thousands)
Adventure sports	1,231	7,710	642
Camping	12,753	344,514	28,709
Driving for pleasure	12,419	49,327	4,111
Eco/Cultural tourism	21,955	56,426	4,702
Fishing and hunting	15,695	127,437	10,620
Other	11,382	37,859	3,155
Picnicking	5,296	11,983	999
Trail activities	28,133	161,688	13,474
Water sports	12,974	67,598	5,633
Winter sports	1,773	8,982	748
TOTAL	123,611	873,524	72,793

Source: U.S. Bureau of Land Management 1996.

In Washington, Oregon, and California, recreational use has also centered on beaches and estuaries from the San Juan Islands in Washington state to San Francisco Bay in California, including windsurfing in the Columbia River Gorge and other recreational opportunities accessed by roads.

4.2.4 Urban Uses

Urban land uses include industrial, commercial, residential, and public facilities. Public facilities include publicly maintained roadways. The public road system within the four states is made up of interstate highways, state highways, and county and city roads, and other local jurisdiction roads. These roads are located extensively throughout each state. Road networks are generally denser in urban areas than rural areas.

Harbors and ports are also examples of urban public facilities. In the analysis area, ports are located in estuarine, coastal environments, and along major river systems (e.g., Portland and Hood River in Oregon, Lewiston in Idaho, and Sacramento in California). Port and harbor

development and management activities include dredging and filling for channel maintenance, boat and gear storage, marine terminals, airports, and office and industrial development, as well as associated roadways. Recreational and commercial fishers also use ports and harbors. There are 18 deep draft public port authorities registered with the American Association of Port Authorities that are located in the analysis area (American Association of Port Authorities 2000).

Urban land uses have increased since 1960 (Table 6). In each state the area of urban land use has more than doubled over the past 30 years. Road networks have similarly increased to support the growth of urban areas. Urban land use areas are expected to grow as the population grows.

Table 6. Urban land use area increases over time.

State	Year: 1960 (1,000 acres)	Year: 1997 (1,000 acres)
Washington	422	1,371
Oregon	239	610
Idaho	74	233
California	2,352	5,922

Source: U.S. Department of Agriculture 1997.

4.3 Geology and Physiography

The geology and physiography of the analysis area were formed over millions of years of geologic, climatological, and ecological processes. This legacy has provided a pattern for current ecological conditions and has fashioned and directed human uses of the diverse terrains and resources within the four physiographic provinces (Fenneman 1928) that encompass the analysis area (Figure 2). Each of the 14 ESUs has a range that spans one or more of these four physiographic provinces. These provinces are described below, moving from the western most province to the east.

Geology, geologic processes, and climate form the physiographic structure in which natural processes operate. Watershed, soil, and atmospheric conditions and processes are also part of the physiographic setting and may be modified by human activities. At the scale of the analysis area and physiographic province, geology, topography, and physiography are controlled by the past 1.5 billion years of plate tectonics, volcanism, glaciers, and their resultant weathering, erosion, and sedimentation processes. The interaction of these processes created the mountain ranges, large river courses, watershed divides, and outcroppings of rocks in their current

locations. These geologic and physiographic elements exert substantial influence over climate, hydrology, and drainage patterns. At the scale of the range of an ESU, the same processes that were responsible for molding the geologic and physiographic elements at the regional scale, also led to the formation of the basins (Figures 4a through 4d). Diverse geologic environments, along with active tectonic, volcanic, and glacial processes have been a controlling influence in the evolution and distribution of aquatic ecosystems. However, human development and use patterns have exerted an increasingly strong influence on the physiography of the analysis area over the past century (Quigley and Arbelbide 1997).

4.3.1 Pacific Border

The Pacific Border province extends 4,000 miles from Kodiak Island in Alaska to the tip of Baja California. The Pacific Coastline of the entire analysis area falls in this province. All but two of the ESUs' ranges (Snake River Basin and Middle Columbia River Steelhead) intersect with this province.

The Basin and Range and the Cascade-Sierra Mountain provinces are adjacent to the Pacific Border province on the east. Just inland of the coastal ranges lies a trough. It forms the eastern edge of the province and includes:

- Puget Sound (Washington)
- Willamette Valley (Oregon)
- Great Central Valley (California)
- Gulf of California (East of Baja California, also known as the Sea of Cortez)

This tectonically dynamic province continues to change as the Juan de Fuca plate is subducted (or sinks) beneath North America off the coast of Oregon, Washington, and British Columbia. The subduction of the Juan de Fuca plate has caused infrequent but very large earthquakes. The San Andreas Fault, a transform fault, marks part of the boundary between the Pacific Plate and North American Plate. The San Andreas fault zone and its subsidiary faults are responsible for much of the seismic activity in California.

Figure 4a. Range of Anadromous Fish – Washington

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Figure 4b. Range of Anadromous Fish – Oregon

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Figure 4c. Range of Anadromous Fish – Idaho

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Figure 4d. Range of Anadromous Fish – California

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4.3.2 Cascade-Sierra Mountains

All but four of the ESUs' ranges (Snake River Basin Steelhead, Ozette Lake Sockeye, and Central and Southern California Coast Steelhead) intersect with the Cascade-Sierra province. California's Sierra Nevada Range is a west-tilting, 350 mile-long block of granite. The range extends from the 14,494-foot Mt. Whitney in the east to near sea level in the west. Eroded material from the Sierra Nevada has filled the Central Valley of California, making extensive agriculture possible.

The Cascade Mountains of the Pacific Northwest province form an arc-shaped band extending from British Columbia to Northern California, roughly parallel to the Pacific coastline. Within this region, 13 major volcanic centers are surrounded by a band of thousands of very small, short-lived volcanoes that have built a platform of lava and volcanic debris. These centers rise above this volcanic platform and dominate the landscape. Glaciers are present on all but the youngest of the peaks. Mount St. Helens, notably, has not been affected by glaciation because of its extensive recent eruptions.

4.3.3 Columbia Plateau

Two of the 14 ESUs addressed in this document (Middle Columbia and Snake River Basin Steelhead) have ranges that lie within the Columbia Plateau province. The province (located in Southern Idaho, extreme northeastern Nevada, and eastern Oregon and Washington), is covered with the products of extensive Cenozoic volcanic eruptions (Quigley and Arbelbide 1997). These are extensive basalt flows that cover a total of about 120,000 square miles. Rivers swollen with glacial meltwater and large Pleistocene floods inundated much of the Columbia Plateau, cutting into the basalt surfaces and forming the cliff-bounded valleys that contain the Columbia River.

Large-scale flooding was an unusual phenomenon of this province. For example, as a result of Pleistocene glaciation, the Okanogan Lobe of the Canadian glacier pushed south into eastern Washington (Quigley and Arbelbide 1997). This diverted the Columbia River and dammed the outlet of a basin that occupied a large area in western Montana. Water pressure eventually caused the dam to break, and produced the largest documented floods ever recorded. The resulting massive erosion produced what is known as the scablands of eastern Washington (Quigley and Arbelbide 1997). The flooding occurred many times, perhaps as many as 70, although estimates vary. The floods cut tremendous channels, and left huge scars to mark their path (Waite and Thorson 1983; Quigley and Arbelbide 1997).

4.3.4 Northern Rocky Mountains

Of the 14 ESUs addressed in this document, only the Snake River Basin Steelhead ESU range

lies within the Northern Rocky Mountains province. This province extends northward from Yellowstone National Park through western Montana into Idaho and extreme northeastern Washington. It is bordered on the east by the Great Plains province, on the south by the Middle Rockies and the Columbia Plateau provinces, and on the west by the Cascade-Sierra Nevada province. Its major geologic feature is the Lewis Thrust Fault. This is a large fault at least 135 miles, and possibly 280 miles long.

This area is characterized by steep topography with narrow valley bottoms, which has discouraged road building and consequent human development. Higher mountains in the province were extensively glaciated, resulting in valleys and basins being filled with alluvium and outwash. Extensive physical and chemical weathering of the granitic rocks has created a thick mantle of regolith (layer of unconsolidated fragmented rock material) that is readily eroded if the local vegetation or soil is disturbed. Land use practices or fishing activities that could contribute to increased erosion could impact salmonid habitat.

4.4 Soils

Most soils in the analysis area are young and thin, and critical soil processes such as nutrient cycling, infiltration, and percolation occur only in the upper few inches or feet of the soil column. Soil-forming and recovery processes are slow; therefore, disturbance can cause long-term changes in the local ecology, including biological and hydrologic processes.

Most soils in the analysis area formed since the time of the last ice age, and are composed of several horizons, or layers. At the surface, there is commonly a thin (generally less than 2 inches), and sometimes discontinuous cover of decaying organic matter. Under this cover of litter and duff is a layer (at most a few inches thick) of dark, highly decomposed organic matter (humus), which covers a mineral layer that may be several feet thick. This mineral layer may contain organic matter, clay minerals, calcium carbonate, and other salts that are transported down the soil column by percolation or burrowing activities. In general, forested environments have more continuous and thicker layers of organic matter than do rangeland environments, but the thickness and amount of organic material varies considerably depending on local vegetation characteristics, climate, relief, and disturbance history. These soil horizons together cover weathered and unweathered parent materials such as bedrock or old stream gravel. Volcanic material is a major component of many soils in the area (Harvey et al. 1994; Henjum et al. 1994; Quigley and Arbelbide 1997).

The susceptibility to soil disturbance within the analysis area (Figure 5) is a predictor of the magnitude of sedimentation that may occur in adjacent water bodies. Sediment transported from upland areas into stream channels affects the quality of salmonid habitat found in streams, rivers, and estuaries (subsection 4.8.4., Sediment and Turbidity). Susceptibility to soil disturbance is not the sole factor determining potential streamload, however. Local watershed climate, topography, geology, vegetation, and hydrology control sediment delivery rate and composition

Figure 5. Soil Susceptibility to Disturbance Stress within the Range of the 14 Threatened ESUs

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(Quigley and Arbelbide 1997; National Research Council 1996). Variation in these watershed characteristics is ultimately determined by the type and quality of habitat found in a given system. Land use practices, through alteration of soil structure, vegetation, and hydrology, can substantially alter the delivery of fine and coarse sediments to streams, thereby affecting salmonid habitats (Swanston 1991; Beschta et al. 1995; Oregon Water Resources Research Institute 1995).

4.5 Climate

The diverse topography and geographic position of the analysis area result in varying local climates. The subclimate regimes range from dry conditions and temperature extremes to the east and south of the analysis area, to wetter, more moderate northern coastal areas. Local climates strongly influence ecological processes such as biological productivity, fire regimes, soils, streamflow, erosion, and human uses of the land and resources.

Coastal areas have a maritime climate with cool, wet winters and warm, dry summers. Inland areas, separated from the moderating influence of the ocean by mountain ranges, have a more extreme continental climate with cold winters and hot summers. In general, the width of the coastal zone that experiences a moderate climate narrows from north to south. In Puget Sound, at the north end of the analysis area, maritime influences extend at least 100 miles inland, producing Seattle's mild climate. At the southern end of the analysis area near San Luis Obispo, California, the maritime zone is only a few miles wide.

Natural air pollution results from forest fires, the gases and particulate matter from volcanoes, and decaying organic materials in oceans and swamps. These sources of natural pollution enter the atmosphere at irregular intervals. Man made pollutants, however, enter the atmosphere at regular intervals via motor vehicle use, chemical plants, oil refineries, pulp and paper mills, as well as sources such as woodstoves, unpaved roads, dry cleaners, gas stations, and manufacturing companies (U.S. Environmental Protection Agency 2001).

Most precipitation in the analysis area falls in the winter months when eastward-moving storms enter the region (Figure 6). Summers in the Pacific Northwest tend to be stable, warm, and dry because the expansion of the North Pacific high-pressure system in early summer blocks moisture coming from the ocean. The Cascade Range extends through much of Washington and Oregon, separating the maritime climate to the west from the eastern portions of those states, leaving these areas with cold winters and warm, dry summers.

The climatic conditions fluctuate over time under the influence of climatic oscillations such as the El Niño-Southern Oscillation, which affects biological production in the ocean and can influence the survival of salmonids (Cederholm et al. 2000; Oregon State University Extension Service 1998). El Niño is an unusual warming of the tropical Pacific Ocean that occurs irregularly at about 3-6 year intervals in response to large scale weakenings of the trade winds

Figure 6. Average Annual Precipitation within the Range of the 14 Threatened ESUs.

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that normally blow westward from South America toward Asia. El Niño affects marine life primarily through the intense warming in regions of normally cool, upwelled water, and the reduction in the supply of high, subsurface nutrients (Enfield and Enfield 2002; Buchanan et al. 2001). During El Niño years, changes occur in the distribution and abundance of many species (Enfield and Enfield 2002). Numbers of spawning Pacific salmon appear to decrease in El Niño years (Cederholm et al. 2000; Oregon State University Extension Service 1998). In contrast to El Niño, La Niña years correspond with conditions that are colder and wetter than average (Enfield and Enfield 2002; Buchanan et al. 2001). La Niña years, which occur in some non-El Niño years, can result in increased numbers of spawning salmon (Oregon State University Extension Service 1998).

4.6 Air Quality

The Federal Clean Air Act (CAA), including the amendments of 1977, 1980, and 1990 (40 CFR 50), is designed to preserve air resources. The CAA requires states to develop strategies for achieving and maintaining compliance with ambient air quality standards (AAQS). Individual states must monitor and report compliance with the AAQS. They must also develop programs designed to achieve and maintain compliance with the AAQS. These programs are outlined in the State Implementation Plans. Washington, Oregon, Idaho, and California each have individual State Implementation Plans that regulate activities with the potential to affect air quality (40 CFR 52).

The CAA established Class I areas as areas in which no further deterioration of air quality would be allowed (40 CFR 50). Air Quality Related Values are a measure of air quality impacts that do not directly affect human health, such as visibility, acid deposition, and impacts to various sensitive ecosystems and plant species (U.S. Department of Agriculture 1992).

Non-attainment areas are areas that are not currently able to meet the AAQS. There are regions within the analysis area that are designated as non-attainment for various pollutants (Environmental Protection Agency 2002). Sources with the potential to emit non-attainment pollutants, such as industrial plants and motor vehicles, are often subject to more stringent regulations. For example, counties with PM₁₀ (particulate matter with a diameter of less than 10 micrometers) non-attainment areas in the analysis area are shown in Figure 7. State and/or local requirements for PM₁₀ non-attainment areas generally require the use of every reasonable precaution to minimize deposition of particulate matter to paved road surfaces. Reasonable precautions generally include, removal of particulate matter from equipment prior to movement on paved streets and the prompt removal of any particulate matter deposited on paved streets (Spokane County Air Pollution Control Authority 2001).

Routine road maintenance activities are not a major source of pollutants, particularly in urban areas, that has the potential to degrade air quality. The primary pollutant of concern for typical road maintenance activities is PM₁₀ (Environmental Protection Agency 1995a). The primary source of PM₁₀ emissions during paved or unpaved road maintenance activities is the mechanical disturbance of material due to passing vehicles and bulk material handling activities such as

Figure 7. PM10 Attainment Status

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grading, loading, transport, and dumping (Environmental Protection Agency 1995b). Unpaved roads, and to a lesser extent paved roads, can be a source of PM₁₀ when winds carry dust from the road surface into the atmosphere (Environmental Protection Agency 1995c; Environmental Protection Agency 1995c). There are emissions of other regulated pollutants; including oxides of nitrogen, carbon monoxide, sulfur dioxide, and trace amounts of various hazardous air pollutants, from vehicle and equipment exhaust.

4.7 Water Quantity

The flow in streams and rivers is a function of the climate, topography, geology, geomorphology, soils, and vegetative characteristics of a watershed. Precipitation may be intercepted by vegetation and subsequently evaporate, or it may reach the ground either directly or as throughfall (rainwater or snowfall that drops from twigs or leaves). Water reaching the ground either evaporates, infiltrates the soil, or flows overland until it reaches a stream or an area where infiltration is possible. Water that infiltrates the soil may be taken up by plants and transpired back into the atmosphere, remain in the soil as stored moisture, percolate through the soil into deep aquifers, or enter streams via subsurface flow. Each of these processes affects the amount and timing of streamflow (Swanston 1991).

Salmonids need adequate streamflows for migration, spawning, incubation, and rearing. Thus, altered flow regimes can have detrimental impacts on salmonids. Low flows during spawning migration may hinder the movement of many stocks over physical barriers including falls, cascades, and debris jams (Spence et al. 1996). Fish may also become stranded as a result of rapid flow fluctuations. Low flows also can lead to excessively high water temperatures that may delay migration, cause outbreaks of disease, and kill fish if temperatures go high enough (NMFS 1996). Reduced flows can also negatively affect fish habitats due to increased deposition of fine sediments in spawning gravels, decreased recruitment of new spawning gravels, and encroachment of riparian and exotic vegetation into spawning and rearing areas (NMFS 1996). Channelization, development, and diking along a river exacerbates peak flow damage in the channel and further reduces the connectivity of a river with its floodplain (National Research Council 1996).

Increased peak flows resulting from urbanization can alter stream morphology and habitat quality (Paul and Meyer 2001). Increasing peak discharges can cause mortality of eggs or alevins in stream gravels as a result of bedload movement (National Research Council 1996). Some benefit can occur with flushing during peak discharges as fine sediments can be removed from streambeds, enhancing spawning and rearing habitat. However, increasing peak discharges can result in excessive flushing that can remove organic matter essential to productivity and can move large woody debris high up on stream banks away from where it can function as habitat (National Research Council 1996). Streambed scour and habitat alteration are additional consequences of increasing the magnitude, duration, and frequency of peak discharge.

Natural watershed hydrology has been greatly altered by human activities. Removal of vegetative cover and the replacement of natural landscapes by farms, cities, and suburbs have increased the volume and rate of stormwater runoff and decreased the rate of groundwater recharge (Goudie 1986; Environmental Protection Agency 2001). In addition, the natural hydrology of many watersheds has been altered by water and power development and flood control projects (subsection 4.7.1, Regional Hydrologic Patterns. Water is commonly diverted directly from rivers, or stored in reservoirs for later diversion for agricultural, industrial, and municipal purposes. Thousands of reservoirs have been built in the analysis area for a variety of such purposes. These reservoirs alter the natural pattern of flow in rivers. Typically, the presence of reservoirs on a river system reduces river flow during the peak spring runoff period and increases flows during the rest of the year (Goudie 1986).

When cities and suburbs replace natural landscapes with buildings and paved surfaces, the percentage of impervious surface in a watershed increases. Roofs of buildings, roads, driveways, and parking lots all add to the impermeable surface in a watershed. The increase in impervious surface tends to increase the magnitude and frequency of flood flows in streams during wet periods and to decrease them in dry periods (Environmental Protection Agency 2001). Typical percentages of impervious surface for different land use types are shown in Table 7.

Table 7. Percent imperviousness for various land use types in Pierce County, Washington.

Land Use Type	Percent Impervious (%)
Low density residential (4 houses per acre)	25
Low density residential (1 home per acre)	11
Multi-family residential	50
Public institutions	30-50
Industrial	85
Commercial	85
Open space	0-5
Agriculture	0-5

Source: Guidance for Basin Planning, Pierce County, Washington 2000.

Roadways can change streamflows. In urban areas where the road network is dense, and the percentage of impervious surface is in the range of 80 to 100 percent, roads represent 20 to 35 percent of the total impervious surface (Pierce County, Washington 2000). For example, in a city with 200-foot by 200-foot blocks and 50-foot roadways, the roadways represent about one-

third of the total impervious surface. In rural areas where there are few roads, the roadway percentage of impervious surface is less than 5 percent (Pierce County, Washington 2000).

In urban areas, roads and highways usually drain to a network of underground storm sewers, which ultimately discharge to surface waters, often at some considerable distance from the source of the runoff. In rural areas, roads and highways typically drain to open roadside ditches where water may percolate into the ground or flow to nearby surface streams or natural drainage channels.

4.7.1 Regional Hydrologic Patterns

In the Coast Range, western Cascades, Puget Lowlands, and the Willamette Valley, frequent and heavy precipitation from November to March leads to a highly variable stream flow regime with peaks that closely correspond in time to peak precipitation (Swanston 1991). In general, precipitation events of similar intensity will result in higher peak flows in the winter, when soils are more fully saturated and vegetative transpiration demands are low, than in the fall (National Research Council 1996). Streamflows are lowest during the summer when precipitation is low, vegetation demands are high, and soil moisture is depleted (National Research Council 1996).

In mid-elevations of the Cascades and northern Sierra Nevada, soils become saturated as rainfall increases in the fall. During the winter, combinations of rain and snow events occur. During rainfall events, water tends to run off quickly to the stream channel because soil moisture is high and vegetation demand is low. Precipitation that falls as snow is stored above ground for varying lengths of time, but it generally melts within a few weeks of falling (Swanston 1991). Thus, increases in streamflow from melting snow will occur days, or even weeks after the peak snowfall. Some of the more notable high-flow events occur when high-intensity rains follow substantial snowfall.

In the high Cascades, Sierra Nevada, Blue Mountains, and northern Rocky Mountains, moisture from precipitation is stored in snowpack through much of the winter and released when temperatures warm in the late spring. Stream flow is characterized by low winter flow followed by rapid flow increases during the spring snowmelt period. As snowpack diminishes, streamflow recedes, and late summer flows are typically low, although minor peaks may result from intense convection storms. In the fall, rainstorms of moderate intensity can cause additional peaks in flow (Swanston 1991).

Below-average precipitation and runoff can have impacts on streams and watersheds. This influence however, is not well documented. It is likely that droughts affect the input of nutrients, external stream material, and large woody debris to stream channels. Within the stream channel, low flows can constrict the available habitat and allow water temperatures to warm, stressing fish or creating thermal barriers that block migration (Spence et al. 1996).

1 Flow regimes throughout the analysis area have been extensively altered by dams, surface and
2 groundwater diversions, and other human activities discussed in the previous section. Stream,
3 riparian, and other aquatic systems throughout the area have been altered by bank and shore
4 structures, urban development, transportation improvements, instream mining activities, flood-
5 control works, agriculture, forestry, and other human activities. A large number of dams have
6 been built in the analysis area for a variety of purposes (Table 8). These dams not only alter
7 natural patterns of flow but also often act as impassible barriers to migrating salmonids.

8
9 When many dams and reservoirs were built, little consideration was given to their adverse
10 effects on salmonids and other fish and wildlife species. In the last two decades, some
11 improvements have been made to benefit fish and wildlife. When hydropower dams are
12 relicensed, their operators are now required to release water during dry periods for fish and
13 wildlife. In recent years, physical modifications to dams and water intakes, transport of smolts
14 around reservoirs, and changes in reservoir operations have improved conditions for salmonids
15 in some river systems.

Table 8. Major dams restricting fish access to habitat.

ESU	Dams/Reservoirs	Hydrologic Unit ¹
Puget Sound Chinook Salmon	Tolt Dam Landsburg Division Alder Dam Elwha Dam	Snoqualmie Lake Washington Nisqually Dungeness-Elwha
Lower Columbia River Chinook Salmon	Condit Dam, The Dalles Dam Bull Run Dam 2 Merwin Dam	Middle Columbi-Hood Lower Columbia-Sandy Lewis
Upper Willamette River Chinook Salmon	Cottage Grove Dam, Dorena Dam Fern Ridge Dam Blue River Dam Big Cliff Dam Green Peter Dam	Coast Fork Willamette Upper Willamette McKenzie North Santiam South Santiam
Hood Canal Summer-run Chum Salmon	Cushman Dam	Skokomish
Oregon Coast Coho Salmon	McGuire Dam Cooper Creek Dam, Soda Springs Dam Ben Irving Dam, Galesville Dam, Win Walker Reservoir Lower Pony Creek Dam	Wilson-Trask-Nestucca North Umpqua South Umpqua Coos
South Central California Coast Steelhead Trout South Central California Coast Steelhead Trout	Chesbro Reservoir, North Fork Pacheco Reservoir Nacimiento Reservoir, Salinas Dam, San Antonia Reservoir San Clemente Dam, Los Padres Dam Lopez Dam, Whale Rock Reservoir	Pajaro Salinas Carmel Central Coastal
Central California Coast Steelhead Trout	Coyote Dam, Warm Springs Dam Phoenix Dam, San Pablo Dam Alameda Reservoir, Anderson Reservoir, Calero Reservoir, Guadalupe Reservoir, Searsville Lake, Stevens Creek Reservoir, Vasona Reservoir Calaveras Reservoir, Chabot Dam, Crystal Springs Reservoir, Del Valle Reservoir, San Antonia Peters Dam, Seeger Dam, Soulejule Dam Pilarcitos Dam, Stone Dam Newell Dam	Russian San Pablo Bay Coyote San Francisco Bay Tomales-Drake Bays San Francisco Coastal South San Lorenzo-Soquel
Central Valley California Steelhead Trout	Black Butte Dam Centerville Dam	Sacramento-Lower Thomes Lower Butte

ESU	Dams/Reservoirs	Hydrologic Unit ¹
Central Valley California Steelhead Trout, con't.	Oroville Dam Camp Far West Dam Monticello Dam Nimbus Dam Keswick Dam, Whiskeytown Dam Englebright Dam	Lower Feather Lower Bear Lower Sacramento Lower American Sacramento-Upper Clear
Central Valley California Steelhead Trout, con't.	Crocker Division Dam, La Grange Dam	Upper Yuba Middle San Joaquin-Lower Merced-Lower
Central Valley California Steelhead Trout, con't.	Goodwin Dam New Hogan Dam	Stanislaus Lower Cosumnes-Lower Mokelumne Upper Stanislaus
	Comanche Dam	Upper Calaveras Mekelumne
Snake River Basin Steelhead Trout	Hells Canyon Dam Dworshak Dam	Hells Canyon Lower North Fork Clearwater
Lower Columbia River Steelhead Trout	Bull Run Dam 2 Merwin Dam	Lower Columbia-Sandy Lewis
Upper Willamette River Steelhead Trout	Big Cliff Dam Green Peter Dam	North Santiam South Santiam
Middle Columbia River Steelhead Trout	Condit Dam Pelton Dam	Middle Columbia-Hood Lower Deschutes
Ozette Lake Sockeye Salmon	N/A	N/A
Columbia River Chum Salmon	N/A	N/A

¹ Hydrologic units are geographic areas representing part or all of a surface drainage basin or distinct hydrologic feature.

Source: Designated Critical Habitat: Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California, February 16, 2000 (65 FR 7764).

4.8 Water Quality

Along with water quantity, water quality is a critical component of aquatic and riparian habitats. Many of the human activities that adversely affect water quantity also degrade water quality. Impoundments, streambank and channel alterations, and disturbances of natural flow regimes can all affect water quality, as can the practice of using surface waters as the recipient for municipal, industrial, and agricultural wastewaters.

Water arrives in a watershed as rain or snow. As it flows downstream, it develops certain physical and chemical characteristics that are derived from the characteristics of the watershed. These characteristics often vary diurnally and seasonally. Aquatic life has evolved to take advantage of the characteristics of water in rivers, streams and lakes. Most aquatic life is adapted to a range of water quality conditions. Human activities in a watershed may alter the quality of water in rivers and streams and if quality characteristics deviate from the natural range then aquatic life may be harmed (Iwamoto et al. 1978; Bjornn and Reiser 1991).

The physical and chemical characteristics of water determine its suitability for different purposes. Various state and Federal agencies have developed water quality criteria that define the physical and chemical characteristics of water that is suitable for a particular purpose or beneficial use. For example, criteria have been established for waters that are suitable for domestic water supply, agricultural water supply, and sustenance of aquatic life in most states (California State Water Resources Control Board 1963; U. S. Environmental Protection Agency 1976). The most widely used water quality criteria are those published by the U.S. Environmental Protection Agency. They are updated and periodically refined, as research results become known (U. S. Environmental Protection Agency 1986).

4.8.1 Water Quality Regulations

In 1972, responding to public concern about deteriorating water quality, Congress passed the Federal Water Pollution Control Amendments, later referred to as the Clean Water Act. The Clean Water Act established a nationwide strategy for abating water pollution. States were required to set ambient water quality standards that would protect the beneficial uses of the waters of the United States, including their use by fish and wildlife.

A national permitting program was established (the National Pollutant Discharge Elimination System) to control the discharge of pollutants to the degree necessary to meet ambient water quality standards. Initially, the permitting program was focused on point sources of pollution; that is, sources which discharge pollutants at a single identifiable point, for example municipal wastewater treatment plants. In 1987, the Clean Water Act was amended to include urban storm water runoff, a diffuse or non-point source of pollutants, in the permitting program.

The Clean Water Act has been successful in that most cases of gross water pollution were eliminated within 25 years of passage of the act. However, many more subtle water quality problems remain, and complete compliance with ambient water quality standards has not been achieved (Patrick 1992; Natural Resources Defense Council 1993).

Periodically, states must prepare a list of water bodies that fail to meet ambient water quality standards and submit it to the U.S. Environmental Protection Agency. The list is known as the 303(d) list. The states must then prepare plans to correct violations of ambient water quality standards. States must determine the reduction in discharge of pollutants necessary to enable

compliance with ambient standards. The reductions in pollutant discharge are distributed amongst polluters and expressed as total maximum daily loads.

Water quality standards are in place in all states in the analysis area. But many water bodies in the analysis area are not in compliance with all applicable ambient water quality standards analysis (Table 9). For example, the Columbia River in the vicinity of Longview, Washington is out of compliance for dissolved oxygen, fecal coliform, temperature and PCBs and total dissolved gases, and the Klamath River in northern California, up to the Oregon border, is out of compliance for dissolved oxygen, nutrients, and temperature. Plans to correct the many violations of ambient standards are at an early stage in their development. Total maximum daily loads have been established for only a small proportion of the water bodies that are not in compliance with ambient standards.

Table 9. Stream miles out of compliance with water quality standards.¹

Stream Miles Listed for Selected Parameters					Total Listed Stream Miles
	Sediment	Nutrients	Pathogens	Toxics	
Washington	18	1	393	134	546
Oregon	1,446	598	2,565	1,426	6,035
Idaho	6,228	2,653	1,539	742	11,162
California	5,823	1,119	725	6,051	13,718

¹ Represents entire state data, and is not specific to boundaries within the 14 ESUs comprising the analysis area.

Source: Atlas of America's Polluted Waters, U.S. Environmental Protection Agency, 2000.

4.8.2 Roadways and Water Quality

Roadways are a source of substances that, if washed into streams and rivers, can harm water quality and aquatic life. The movement of vehicles along roadways erodes material from the surface and margins of the roadway. Vehicles deposit oil and grease and materials derived from tires, brake pads, and other mechanical parts on the roadway surface. Travelers often dispose of litter within roadway rights-of-way. When rain falls or snow melts, the materials accumulated on the roadway surface are carried into the roadway drainage system and ultimately into the waters of the United States.

Typical characteristics of runoff from roadways in urban and rural areas are shown in Table 10.

Roadway runoff is relatively lightly polluted compared to untreated municipal or industrial wastewater. In urban areas, roadway runoff is usually the most contaminated component of urban runoff.

Table 10. Characteristics of stormwater runoff from highways in urban and rural areas.

Constituent	Unit	Median Event Mean Concentration	
		Urban Highways (1)	Rural Highways (2)
Total Suspended Solids	mg/L	142	41
Volatile Suspended Solids	mg/L	39	12
Total Organic Carbon	mg/L	25	8
Chemical Oxygen Demand	mg/L	114	49
Total Phosphorus	mg/L	0.4	0.16
Total Nitrogen	mg/L	1.83	0.87
Nitrate and Nitrite Nitrogen	mg/L	0.76	0.46
Total Copper	mg/L	54	22
Total Lead	mg /L	400	80
Total Zinc	mg /L	329	80

1. Highways with average daily traffic greater than 30,000 vehicles.
2. Highways with average daily traffic less than 30,000 vehicles.

Source: Federal Highway Administration 1990; U.S. Environmental Protection Agency 1983.

Roadway runoff was not regulated until 1987 when the Clean Water Act was amended to include urban runoff in the National Pollutant Discharge Elimination System. The amendments required urban areas with a population of 100,000 or greater to obtain National Pollutant Discharge Elimination System permits to discharge urban storm water to the waters of the United States. Urban storm water discharge permits are often jointly held by groups of cities and counties and cover an entire urban area including roads and streets owned by the cities and counties. State departments of transportation, the owners of major roadways in urban areas, typically hold separate urban storm water discharge permits that cover their facilities within urban areas throughout a particular state. The storm water permits cover the discharge of pollutants to the waters of the United States from an entire urban area regardless of whether or not the discharge occurs at a single identifiable point. Developers of industrial, commercial, and residential properties are also required to obtain permits during construction and in some cases for ongoing management.

Urban storm water permits contain conditions requiring permit holders to implement storm water management plans. The storm water management plans typically consist of a list of best management practices that are intended to prevent or lessen the discharge of pollutants in storm water runoff. The best management practices address a range of construction and maintenance activities that occur in urban areas including those that address routine road maintenance activities. Urban storm water management plans also contain similar best management practices for road maintenance and such practices commonly address catch-basin and roadside ditch cleaning, spill clean up, use of herbicides, and other activities. As a result, agencies responsible for roadway and road maintenance in urban areas with populations exceeding 100,000 are implementing measures designed to reduce the discharge of pollutants in storm water runoff.

In rural areas, and urban areas with a population of less than 100,000, a National Pollutant Discharge Elimination System permit is not needed to discharge urban runoff to waters of the United States, although permits are expected to be required for urban areas with populations between 10,000 and 100,000 in the next several years. In general, storm water management plans for these areas have not been developed. Agencies responsible for roadway and road maintenance are not required to implement measures designed to reduce the discharge of pollutants in storm water runoff, but some are doing so voluntarily. An exception occurs in California where the California Department of Transportation and the California State Water Resource Control Board's storm water management plan addresses storm water runoff from all state roadways, whether in urban areas with populations greater than 100,000 or elsewhere (California Department of Transportation 2001).

4.8.3 Water Temperature

Heat energy is transferred to and from streams and rivers by a variety of processes including short-wave radiation (primarily direct solar), long-wave radiation, convective mixing with the air, evaporation, conduction with the stream bed, and mixing with inflow from groundwater or tributary streams (Beschta et al. 1987; Sullivan et al. 1990). These processes occur in all streams, but the importance of each process on stream temperatures varies with location and season (Sullivan et al. 1990). Direct solar radiation is generally the dominant source of energy input to streams and rivers. The amount of solar radiation that reaches and is absorbed by streams and rivers is influenced by season, latitude, topography, orientation of the watershed, local climate, and riparian vegetation (Brown 1980; Beschta et al. 1987; Caldwell et al. 1991).

Water temperature influences all aspects of salmonid physiology, behavior, and ecology. Temperatures approaching or exceeding the physiologically tolerable range can cause direct mortality or acute stress in salmonids. In addition, relatively small increases in stream temperature at any time of year can adversely affect salmonids by changing metabolic requirements, behavior, rate of development of embryos and alevins, migration timing, competitive interactions, predator-prey interactions, disease-host relationships, and other important ecological functions (Monan et al. 1975; Bjornn and Reiser 1991; Groot 1982).

Water temperature also indirectly affects salmon survival. Foraging rates of piscivorous fish are directly related to temperature (Vigg and Burley 1991), and the rates of infectivity and mortality of several diseases are known to be directly related to temperature (NMFS 1998).

Freshwater temperature is critical for the survival of salmonids in early life stages. Embryo survival and fry emergence depend upon appropriate water temperatures (less than 57°F for most species) (Spence et al. 1996). Also, freshwater temperatures experienced by out-migrating juvenile salmon have been shown to affect survival (Monan et al. 1975, as cited in Spence et al. 1996; Bjornn and Reiser 1991, as cited in Spence et al. 1996; Groot 1982, as cited in Spence et al. 1996). Immigrating adults can be delayed by excessively warm water temperatures (NMFS 1998). Delay can reduce the ability of adult fish to survive to spawning, as well as vigor and fecundity during spawning (NMFS 1998).

Water temperatures exceed ambient water quality standards in many streams in the analysis area during the summer months. Primary causes are flow depletion as a result of diversion for irrigation and municipal water supply, impoundments, and loss of shading provided by riparian vegetation due to changes in land use such as urbanization.

4.8.4 Sediment and Turbidity

Wind and water erode material from rocks and soils, which is then carried toward the ocean by rivers. The material may be in the form of bedload, boulders, gravel, or sand moving along river bottoms, or it may be suspended or dissolved. Erosion and the movement of rock gravel and sand by rivers is a natural process to which salmonids are evolutionarily adapted. However, excessive erosion caused by human activities can harm salmonids and macro-invertebrates (National Research Council 1996) (subsection 4.4, Soils). Macroinvertebrates are also impacted by human activities and are monitored as indicators of stream health. Taxa richness and abundance of macroinvertebrates, among other attributes, are changed systematically along a gradient of human influence, measured as percent impervious area. Some attributes decline as human influence increases (total taxa richness and richness of intolerant taxa) and others increase (number of tolerant taxa). Macroinvertebrate assemblages are indicators of impacts of logging, livestock grazing, recreation, and urbanization, and can be related to the health of salmonid populations (NMFS 1998).

Suspended sediment, or the portion of the sediment load suspended in the water column, is of particular concern for its ability to adversely impact aquatic populations (Hicks et al. 1991). The grain size of suspended sediment is usually less than 1 millimeter in diameter (e.g., clays, silts, and fine sands), while particles greater than 1 millimeter are transported as bedload (Everest et al. 1987). During high peak flows (e.g., storm events) particles greater than 1 millimeter can be transported as suspended sediment (Sullivan et al. 1987). The concentration of suspended material in water is usually measured as turbidity. Turbidity is a measure of the amount of light scattered or absorbed by a fluid and it is measured in nephelometric turbidity units or NTUs.

Suspended sediment can enter watercourses by various mechanisms. Mobilization of small particles is generally achieved through surface erosion (National Research Council 1996). Surface erosion is normally associated with precipitation but can occur chronically if human activities generate continuous runoff of sediment-rich water to streams (National Research Council 1996). Surface erosion is a normal process, and the frequency depends mostly on the geology and erosiveness of soils and underlying rock and on the intensity and duration of rainfall and snow melt (National Research Council 1996). Some areas have naturally high erosion rates; examples include sandstone-dominated coastal river basins in northern California and western Oregon, granitic sediments in northern and central Idaho, and glacial-lacustrine deposits in northwestern Washington. These areas are sensitive to impacts of logging and road building on erosion rates (National Research Council 1996).

Suspended sediment concentrations tend to be highest during periods of peak flow and then decline as flows diminish through late summer and into fall. Particulate materials can physically abrade and mechanically disrupt respiratory structures (e.g., fish gills) or surfaces (e.g., respiratory epithelia of benthic macroinvertebrates) in aquatic vertebrates and invertebrates (Rand and Petrocelli 1985). In addition, sediment loading can impact listed species of salmonids by causing local fluctuations of pool size and/or perturbations in streambed compositions (Lloyd et al. 1987; Hicks et al. 1991; Lake and Hinch 1999), and impair foraging efficiency and disrupt social behavior (National Research Council 1996). Stream sediment inputs could also have beneficial effects for salmonids, however, if coarse sediments are introduced by glacial-lacustrine deposits or high flow events causing mass wasting or slumping that increase the suitability of streambed structure for salmonids (National Research Council 1996).

In streams, turbidity is usually a result of suspended particles of silts and clays, but also organic compounds, plankton, and microorganisms. Turbidity varies greatly as a result of natural factors, so states in the analysis area have established standards for turbidity relative to background levels, rather than absolute standards. For example, the Idaho Department of Environmental Quality and the Washington Department of Ecology specify that turbidity shall not exceed 5 nephelometric turbidity units over background levels when the background level is 50 nephelometric turbidity units or less, nor increase more than 10 percent when background is more than 50 nephelometric turbidity units (U.S. Army Corps of Engineers 1999). Oregon specifies that no more than a 10 percent increase over background is allowed (Oregon Department of Environmental Quality 2002). Construction, logging, and agricultural activities commonly cause violations of turbidity standards in the analysis area.

4.8.5 Dissolved Oxygen

Dissolved oxygen refers to the concentration of oxygen dissolved in water. Adequate dissolved oxygen concentrations are important for supporting fish, invertebrates, and other aquatic life. Salmon and steelhead are particularly sensitive to reduced dissolved oxygen.

1 Dissolved oxygen in water is dependent upon not only the saturation concentration but also upon
2 the oxygen losses (sinks) and sources (Novotny and Olem 1994). The primary sinks are
3 respiration and the biochemical oxygen demand of substances in water. Major sources of
4 dissolved oxygen include photosynthesis and dissolution of atmospheric oxygen in water as
5 oxygen concentrations are depleted (reaeration). High temperatures increase the rate of
6 biochemical oxygen demand (MacDonald et al. 1991). The capacity of water to hold oxygen in
7 solution is inversely proportional to temperature, causing high stream temperatures to result in
8 low dissolved oxygen. In general, most forest streams have cool temperatures, rapid aeration
9 rates, and relatively low oxygen demands, yielding stream water that is normally close to or at
10 saturation. Full saturation does not usually occur in slow; low-gradient streams where the rate of
11 aeration is slow, sites where fresh organic debris (particularly fine debris) causes a large
12 biochemical oxygen demand; or in warm, well-nourished streams where high levels of
13 photosynthesis and respiration cause daily fluctuations in dissolved oxygen (MacDonald et al.
14 1991).

15
16 Salmonids require high levels of dissolved oxygen throughout most of their life stages with early
17 life stages being most sensitive to reduced dissolved oxygen levels (Spence et al. 1996).
18 Dissolved oxygen may be lowered in streams and rivers as a result of industrial and municipal
19 discharges, nutrient-induced algal blooms, temperature increases, and increased siltation, which
20 hinders exchange of water between surface and intragravel waters. Low dissolved oxygen levels
21 influence developing eggs and alevins in a number of ways including reduced survival, retarded
22 or abnormal development, delays in time to hatching and emergence, and reduced size of fry
23 (Spence et al. 1996). In juveniles and adults, low dissolved oxygen impairs swimming
24 performance, reduces growth, and inhibits migration (Pacific Fishery Management Council
25 1999; Brett 1971; Warren 1971; Moyle and Cech 1982).

26
27 All states in the analysis area have established dissolved oxygen standards designed to protect
28 cold water fish, including salmonids. Compliance with ambient standards for dissolved oxygen
29 is most problematic in the summer months in streams diminished by agricultural water
30 diversions and unprotected by riparian vegetation.

31
32 In addition to temperature, dissolved oxygen, and sediment, salmonids can also be adversely
33 affected by a variety of toxic pollutants (National Research Council 1996). These contaminants
34 can enter streams as chronic inputs, such as industrial effluent or runoff from agricultural and
35 mining areas, or as episodic inputs, such as chemical spills during transportation or failure of
36 containment structures. Effects vary depending upon the chemicals, exposure, and interactions
37 with other chemicals, but can range from direct mortality and behavioral or morphological
38 abnormalities to bioaccumulation of substances in tissues, making fish unsafe for human
39 consumption (National Research Council 1996).

4.9 Fish and Wildlife

4.9.1 Fish

Aquatic ecosystems in the study area are highly diverse and produce a wide variety of species adapted to them. Washington, Oregon, Idaho, and California each have unique habitats ranging from rainforest, to desert, to alpine, with transitional ecotypes between these more distinct habitats. Aquatic habitats are equally varied; from massive state and physiographic province-spanning watersheds to small marshes (Moyle and Davis 2000). With the exception of a few fish species adapted to specific regional habitat conditions, such as those found in the Klamath Basin or Goose Lake/Pit River complex, the majority of fish in the region are widespread and distributed across many physiographic provinces.

The status of fish in the region ranges from Federally endangered native fish to populations of invasive species expanding at the peril of other co-occurring species. Of the 88 native fish taxa present in the Columbia Basin in Washington, Oregon, Idaho, and California, for example, 45 have been determined to be at risk (threatened, endangered, or of special concern, as determined by various agencies and organizations) (Quigley and Arbelbide 1997). Washington, Oregon, Idaho, and California together are home to more than 250 fish species including over 140 fish species introduced from other regions in the United States, Europe, Africa, and Asia (Moyle and Davis 2000; He and Kitchell 1990). Non-salmonid anadromous fish residing in the study area include the Pacific lamprey (*Lampetra tridentata*), sturgeon (*Acipenser spp.*), and the non-native American shad (*Alosa sapidissima*). Bull trout (*Salvelinus confluentus*) anadromy is common among chars in cold climates (Hubbs and Lagler 1958; Bond 1992), and although anadromy is not found in the study area, Bond (1992) believed that it was an important part of the life history and historical distribution patterns for bull trout in the Pacific northwest, and may have acted as a mechanism for coastal distribution.

Northern pikeminnow (*Ptychocheilus oregonensis*), a native species and major predator of outmigrant salmon smolts, have exhibited major population increases attributed primarily to dam impoundments that create ideal foraging areas for the species. Impoundments also increase juvenile salmon travel time in these areas; further increasing predatory pressures (NMFS 1998). Whiting (*Merluccius bilinearis*) and mackerel (*Scomber scombrus*) are also known to prey on juvenile salmon. Fishing activities that reduce the size of predator populations may result in decreased pressure on salmonid populations (Pacific Fishery Management Council 1999).

4.9.1.1 Native Fish Species

Washington

Seventy-seven fish species are recognized in Washington state, of which 51 are considered native (Smith and Collopy 2002).

Oregon

Sixty-three fish species are considered native to Oregon, including the endemic chub, suckers, and lamprey of the Klamath Basin area in southwest Oregon, northern pikeminnow, and Federal and state threatened Lahontan cutthroat trout (*O. clarki*) of interior eastern Oregon. Of the 73 species, 45 percent are at risk of extinction or have declined to levels that warrant state or Federal efforts to protect them (Oregon Progress Board 2000).

Idaho

Fourteen of Idaho's 39 native fish are considered state priority species of concern, including the Snake River finespotted cutthroat trout (*O. clarki*), Bonneville cisco (*Prosopium gemmiferu*), and Shoshone sculpin (*Cottus greenei*). Six native fish species are Federally listed in Idaho as well, including Pacific lamprey (also state endangered), and bull trout.

California

California is home to the greatest number of recognized native species, based on research conducted by Moyle and Davis (2000), derived largely from Shapovalov and others in 1959 and 1981. One hundred twenty-five species have been identified as of 2000, with 72 considered native fish. Habitat in California supports some of the naturally rarest fish in the west, such as the Saratoga Springs pupfish (*Cyprinodon n. nevadensis*) found only in the 10-meter-diameter Saratoga Springs in Death Valley National Park.

4.9.1.2 Invasive Fish Species

Non-native species have been introduced in the ESUs in large numbers through intentional state and Federal fisheries management actions, accidental release of aquarium fish, and illegal game fish stocking activities (Leubke 1978). The effects of co-occurring non-native fish range from benign to the total collapse and extinction of native stocks due to predation or competition. For example, the piscivorous northern pike (*Esox lucius*) has been shown to substantially reduce prey density and has the potential to cause large-scale changes in fish communities, even resulting in species elimination (He and Kitchell 1990). Pike are present throughout the United States including Washington, Oregon, Idaho, and California. Other invasive fish threatening native species and their habitats in the study area include brook, brown, and lake trout (family Salmonidae); largemouth, smallmouth, and striped bass (family Moronidae); walleye (*Stizostedion vitreum*); bullhead (*Ameiurus spp.*); and mosquitofish (*Gambusia spp.*). Indigenous and non-indigenous salmonids introduced outside of their native ranges compete for food, space, and spawning areas (He and Kitchell 1990). In Washington state, concerns are being raised about fish farming and escapement of pen-reared fish into Puget Sound. Bass, walleye, bullhead, and mosquitofish are among the most voracious predators of salmonid eggs, fry, smolts, and small adults (Dentler 1993).

Washington

In the Columbia Basin, which includes Washington as well as parts of Idaho and Oregon, 55 of

the 143 fish species are non-native (Quigley and Arbelbide 1997). About half of the approximately 60 species of fish in the Snake River Basin are non-native (NMFS 2000). Introductions of non-native species along with habitat modifications have increased predator populations in numerous river systems, and resulted in higher predation levels for salmon (Myers et al. 1998). Of the 77 species found in Washington, 26 are non-native, including brook trout, large and smallmouth bass, walleye, and channel catfish, all species implicated in the decline of native species through competition or direct predation (Quigley Arbelbide 1997).

Oregon

Habitat in Oregon supports 63 recognized native species and subspecies, with more than 32 species of freshwater fish species introduced from other regions. Many of these populations are self-sustaining and make up approximately one-third of Oregon's freshwater fish fauna (Oregon Progress Board 2000).

Idaho

Of 100 recognized Idaho fish species, only 39 are considered native. As with the other states in the analysis area, Idaho native fish are subject to predation by walleye, bass, and catfish, and direct habitat competition from brown and brook trout as well as many trout species introduced from other pacific northwest regions.

California

Of 125 California fish species identified by Moyle and Davis (2000), 53 are non-native. In 1959, the number of native resident or anadromous species recognized was 64 (Shapovalov et al. 1959), while the number of non-native species was 32. In 1981, the numbers were 66 and 45 (Shapovalov et al. 1981), respectively, indicating in the past 20 years non-native fishes have become established in California at a rate of about 1 species every 3 years (Moyle and Davis 2000).

4.9.1.3 Threatened and Endangered Fish Species

Currently, 57 ESUs of West Coast salmonids have been described (51 under the jurisdiction of NMFS, 6 under the jurisdiction of the U. S. Fish and Wildlife Service). Twenty-six ESUs are currently listed as threatened or endangered under the ESA. The analysis area includes 14 ESUs considered in the July 2000, 4(d) rule (subsection 4.1, Introduction) (Appendix C).

Salmon and trout in the analysis area are anadromous, exhibiting a unique life history that takes place in both fresh and marine water. Anadromous fish spawn in freshwater, laying eggs in nests in the gravel called redds, and emerging as fry. The juvenile fish, referred to as parr or fingerlings as they increase in size, spend various amounts of time in freshwater and then begin their migration to the marine environment. Before reaching the marine environment, salmonids undergo physiological changes (smoltification) in preparation for marine life. Timing of migration and length of marine residence vary with species. To complete their life cycle,

1 anadromous fish return to freshwater to spawn and die (except for steelhead, which can spawn
2 multiple times before dying), generally to the streams in which they hatched.

3
4 Factors that contribute to the decline of Pacific salmonids include habitat loss and degradation,
5 the effects of water development projects (e.g., hydropower dams, power plants, and water
6 diversions), changes in stream flow patterns and amount, predation by and competition with
7 hatchery fish (as well as genetic effects), fish harvest, disease and predation, and inadequate
8 regulatory mechanisms (NMFS 1998a; NMFS 1998b; Spence et al. 1996; CDFG 2001). These
9 factors for decline are described here in a general way so that they may serve as a basis for the
10 discussion of ESU-specific factors found in subsequent sections. Aspects of each factor for
11 decline apply to all salmonids. The major factors for decline are described in Appendix D. It is
12 important to note that the factors for decline are often inextricably linked and, together, can
13 affect salmonids in ways that make it difficult to isolate any one factor as the cause of population
14 decline. Nonetheless, the ESU-specific discussions identify the primary factors for decline
15 where it is possible to do so. Descriptions of the 14 ESUs covered under the July 2000 4(d) rule
16 are included in Appendix C. This includes information about life histories, species status, and
17 factors for decline specific to each ESU.

18
19 Threatened and endangered fish species in the analysis area, in addition to the 14 threatened
20 ESUs described above, include one species from Washington, nine species and subspecies from
21 Oregon, two species from Idaho, and fifteen species and subspecies from California. Of
22 particular note, the endangered bull trout (*Salvelinus confluentius*) are present in all four states,
23 and in a variety of ecoregions (Bond 1992). Bull trout require near pristine cold water habitat
24 conditions and may display pronounced response to the actions described in this limit.

25
26 Other species listed include lahontan trout, one of many cutthroat trout subspecies listed in the
27 region; redband trout (*O mykiss*), a rainbow trout subspecies; several unique Klamath basin
28 chub, suckers, and lamprey (families Cyprinidae, Catostomidae, and Petromyzontidae) in both
29 Oregon and California; and the desert-adapted Owens pupfish (*Cyprinodon radiosus*) of
30 California's Great Basin. Appendix E provides a complete list of Federally listed threatened and
31 endangered species by state. Appendix E also provides a complete fish species and status list by
32 state.

33 34 35 **4.9.2 Wildlife**

36
37 Species that occur in riparian, estuarine, or marine habitats in the range of the ESUs are of
38 concern in this analysis. As with vegetation, wildlife associations vary generally by ecoregion
39 (Figure 8). Wildlife species associations for individual ecoregions are provided in Appendix F.
40 Mule deer are common throughout the analysis area, and other large mammals include bobcat,
41 mountain lion, and coyote. Birds and small mammals are numerous and varied by ecoregion.
42 Habitat modifications have reduced populations of large mammals in some areas including the
43 grizzly bear and wolf. Wildlife on the Federal threatened and endangered species list for

Figure 8. Ecoregions in and Adjacent to the Analysis Area

CLICK HERE TO OPEN FIGURE

1 Washington, Oregon, Idaho, and California include mammals, birds, reptiles, amphibians,
2 insects, and fish (Appendix E). The greatest number of listed species is found in California (110
3 species) followed by Oregon (36 species), Washington (30 species), and Idaho (21 species).
4

5 Wildlife species selectively use certain habitats to varying degrees. O’Neil and Johnson 2001
6 analyzed data on wildlife species in Washington and Oregon to determine the level of
7 association for different habitats. The highest number of species was found in agricultural areas
8 and riparian/wetland areas, followed by forest/woodlands. The lowest number of species was
9 found in coastal areas.
10

11 Table 11 gives a partial list of the hundreds of species of birds, mammals, reptiles, and
12 amphibian to be found in the area inhabited by the 14 threatened salmonid ESUs. Though
13 wildlife do not all have direct interactions with salmonids, their sustained presence stands as an
14 indicator of the health of the ecoregions in which they dwell. That is, where native populations
15 of wildlife species are strong and diverse, the local ecology is more likely to be in better shape
16 than it is where the populations are diminished or experiencing downward trends. It is therefore
17 of interest to determine in a general way what effects an action has on local
18 wildlife—particularly when the effects on specific species or populations cannot be
19 determined—because that analysis strongly correlates to the effects an action has on the human
20 environment as a whole.

Table 11. A partial list of the wildlife species inhabiting the region covered by the 2000 4(d) rule.

Birds	<p><i>Songbirds:</i> Warblers, flycatchers, finches, chickadees, thrushes, larks, blackbirds, swallows; e.g., evening grosbeaks, mountain bluebirds, varied and hermit thrushes, western meadowlarks, horned larks, kingbirds</p> <p><i>Cavity Nesters:</i> Flickers, woodpeckers, nuthatches, buffleheads, wood ducks, some owls, and sapsuckers; e.g., Pileated woodpeckers, black-backed woodpeckers, Northern flickers, burrowing owls, red-napped sapsuckers</p> <p><i>Raptors/Scavengers:</i> Vultures, hawks, falcons, owls, crows, jays, eagles, ospreys, gulls; e.g., Steller’s jays, red-tailed hawks, kestrels, bald eagles, golden eagles, magpies, turkey vultures, marsh hawks, common ravens, Swainson’s hawks</p> <p><i>Upland gamebirds:</i> Pheasant, quail, grouse, partridges, chuckar, and turkeys; e.g., blue, sage, and ruffed grouse; California and mountain quail, mountain partridges</p> <p><i>Waterfowl:</i> Ducks, geese, widgeons, coots, scaups, and grebes; e.g., wood, ruddy, pintail, and harlequin ducks; mergansers; Canada geese; common mergansers</p> <p><i>Shore-, sea-, and water birds:</i> Sandpipers, dunlins, plovers, puffins, cormorants, herons, guillemots, murrelets, terns, and murres; e.g., Caspian terns, common murres, pigeon guillemots, tufted puffins, marbled murrelets, great blue herons, black-capped night herons, double-crested cormorants, American avocets, sandhill cranes, lesser yellowlegs</p>
Land Mammals	Black bears, grizzly bears, elk, mule deer, mountain goats, pronghorn antelope, river otters, bighorn sheep, mountain lions, beavers, nutria, muskrats, lynx, bobcats, badgers, fishers, squirrels, bats, blacktail deer, coyotes, grey wolves, shrews, voles, rabbits, hares, porcupines, skunks, mice, racoons, opossums
Herpetofauna (Reptiles and Amphibians)	Lizards, snakes, turtles, frogs, toads, salamanders, and newts; e.g., western fence lizards, Dunn’s salamanders, red-legged frogs, tailed frogs, yellow-legged frogs, Northern alligator lizards, painted turtles, common garter snakes, rubber boas, Great Basin spadefoot toads, western rattlesnakes, western skinks, gopher snakes
Marine Mammals	Grey whales, killer whales, harbor seals, eared seals, Stellar’s sealions, sea otters

4.9.2.1 Threatened and Endangered Wildlife Species

A total of 153 wildlife species are identified as Federally threatened, endangered, candidate, or proposed for listing under the Federal ESA in the analysis area. Forty-seven additional wildlife species are listed as threatened and endangered by state resource agencies in Washington, Oregon, Idaho, and California.

Dietary and habitat requirements vary greatly from one species to another. However, one threatened species, the bald eagle, which is found in all of the physiographic provinces under study in Washington, has been shown to prey on large numbers of salmonids. In a study of bald eagles on the lower Columbia River, Garret et al. (1988) noted that salmonids comprised approximately 12 percent of the diet. In *The Bald Eagle*, Stahlmaster (1987) presents the results of 20 foraging studies with widely varying results based upon locality.

Another threatened species that has a negative effect on at least one salmonid population is the Steller's sea lion (NOAA 1997).

Washington state has a total of 25 Federally listed wildlife species. Although no additional species have been proposed for listing, NMFS is reviewing the status of nine species that are currently on the candidate list (Washington Department of Fish and Wildlife 2001). Status reviews will determine whether or not the Federal agencies will list the candidate species. In addition, the state has 14 state-listed species, 20 candidates, and no proposed species, that are not Federally listed, or candidates (Washington Department of Fish and Wildlife 2001).

Washington

Along Washington's coast and eastward to the Willamette Valley, Federal and state listed species include, but are not limited to, sea otter, Stellar's sea lion, Columbian white-tailed deer, marbled murrelet, brown pelican, snowy plover, purple martin, bald eagle, northern spotted owl, sandhill crane, western pond turtle, Dunn's salamander, Van dyke's salamander, and the Oregon silverspot butterfly (Csuti et al. 1997; Sibley 2000; Leonard et al. 1993; Storm and Leonard 1993).

Within the Cascade Mountains of Washington, Federal and state listed species include, but are not limited to, grizzly bear, gray wolf, wolverine, Harlequin duck, bald eagle, golden eagle, and the Cascade torrent salamander (Csuti et al. 1997; Sibley 2000; Leonard et al. 1993; Storm and Leonard 1993).

Federal and state listed species associated with the Washington portion of the Columbia Plateau province include, but are not limited to, the black-tailed jackrabbit, Washington ground squirrel, northern goshawk, golden eagle, peregrine falcon, burrowing owl, white-headed woodpecker, sandhill crane, sharp-tailed grouse, and sage sparrow (Csuti et al. 1997; Sibley 2000).

Oregon

Oregon has a total of 19 Federally listed species, and four candidates for Federal listing (Oregon Natural Heritage Program 2001). In addition, the state has four state-listed species, which are not Federally listed or proposed for such listing (Oregon Natural Heritage Program 2001).

Along Oregon's coast range and westward, Federal and state listed species include, but are not limited to, sea otter, Stellar's sea lion, northern sea lion, Columbian white-tailed deer, marbled murrelet, brown pelican, snowy plover, purple martin, bald eagle, northern spotted owl, western pond turtle, Oregon spotted frog, Dunn's salamander, Van dyke's salamander, and the Oregon silverspot butterfly (Sibley 2000; Csuti et al. 1997; Leonard et al. 1993; Storm and Leonard 1993).

Within the Cascade Mountains of Oregon, Federal and state listed species include, but are not limited to, grizzly bear, California wolverine, Canada lynx, Cascade torrent salamander, Harlequin duck, and bald eagle (Csuti et al. 1997; Sibley 2000; Leonard et al. 1993).

Federal and state listed species associated with the Oregon portion of the Columbia Plateau province include, but are not limited to, the black-tailed jackrabbit, Washington ground squirrel, kit fox, northern goshawk, golden eagle, peregrine falcon, burrowing owl, white-headed woodpecker, sandhill crane, sharp-tailed grouse, and sage sparrow (Csuti et al. 1997; Sibley 2000).

Idaho

Idaho has a total of 14 Federally listed wildlife species, two candidates for Federal listing, and no species proposed for Federal listing. In addition, the state has three state-listed species, which are not listed Federally or candidates for such listing (Idaho Department of Fish and Game 2002a).⁵

Federal and state listed species associated with the Idaho portion of the Columbia Plateau Province include, but are not limited to, northern Idaho ground squirrel, southern Idaho ground squirrel, peregrine falcon, Columbia spotted frog, Banbury Springs limpet, and Bruneau hot springsnail (Interior Columbia Basin Environmental Management Project 1997).

The middle Rocky Mountains physiographic province forms the eastern border of Idaho state. Federal and state listed species in this province include, but are not limited to, gray wolf and Canada lynx (U.S. Forest Service 2002).

California

California has a total of 26 Federal threatened wildlife species, 54 endangered, no candidates, and nine species proposed for Federal listing. In addition, the state has 26 state listed species

⁵ The Idaho Department of Fish and Game species classification system differs from the Federal system in that it does not have 'candidate' or 'proposed' designations.

that are not Federally listed or candidates for such listing (California Department of Fish and Game 2002).

California's Pacific Border province is characterized by many Federal and state listed species including, but not limited to, salt-marsh harvest mouse, San Joaquin kit fox, southern sea otter, Guadalupe fur seal, marbled murrelet, northern spotted owl, brown and California brown pelican, western snowy plover, bald eagle, southwestern willow flycatcher, Alameda whipsnake, green sea turtle, arroyo toad, California red-legged frog, and the Lotis blue butterfly (Jameson and Peeters 1988; Zeiner et al. 1988; Zeiner et al. 1990; Sibley 2000; California Department of Fish and Game 2002).

Within the Sierra Mountains of California, Federal and state listed species include California bighorn sheep, wolverine, great gray owl, California spotted owl, and mountain yellow-legged frog (Jameson and Peeters 1988; Zeiner et al. 1988; Zeiner et al. 1990; Sibley 2000).

4.10 Vegetation

Vegetation status and trends are described below by physiographic provinces. As described in subsection 4.3, Geology and Physiography, the 14 ESUs span four physiographic provinces: the Pacific Border, the Cascade-Sierra Mountains, the Columbia Plateau, and the Northern Rocky Mountains (Figure 2). This discussion also provides vegetation information at a more detailed scale (ecoregion level). Ecoregions are geographic groupings of ecologically similar areas (Bailey 1995). Bailey's (1995) system of classification is hierarchical; it contains different levels of classification. Domains, divisions, and provinces are three levels of grouping, with domains being the least detailed, and provinces being the most detailed. In this discussion, ecoregions are described at the province level. Ecoregion provinces share common features of soil, climate, geology, and hence, vegetation. The range of the 14 ESUs span all or part of 11 ecoregions (Figure 8). Appendix F provided more detailed summaries of the vegetation and wildlife of these ecoregions.

4.10.1 Pacific Border Province

The Pacific Border province intersects with seven ecoregions. The Cascade Mixed Forest and Pacific Lowland Mixed Forest ecoregions lie in Washington and Oregon. The Sierran Steppe ecoregion begins in southern Oregon and extends south through most of the length of California. The remaining four ecoregions, California Coastal Steppe, California Dry Steppe, California Coastal Chapparral, and California Coastal Range, lie entirely within California.

In the Pacific Border province, coastal areas are generally forested. Coastal forests (Cascade Mixed Forest ecoregion) in Washington and Oregon are primarily coniferous, dominated by Douglas-fir (*Pseudotsuga menziesii*) and hemlock (*Tsuga heterophylla*), including some of the

world's largest trees (Smith and Collopy 2002). In valleys further inland in Washington and Oregon (Pacific Lowland Mixed Forest ecoregion) coniferous forests also contain deciduous species, including big-leafed maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera*), and Oregon ash (*Fraxinus latifolia*). Forested areas in this ecoregion are interspersed with wetlands and grasslands containing tree species such as Oregon white oak (*Quercus garryana*) and Pacific madrone (*Arbutus menziesii*) (Smith and Collopy 2002; Bailey 1995).

Extensive logging has occurred in forested areas in the Pacific Northwest during the last 50 years. By 1988, estimates of the status of coastal forests indicated that 75 percent of Washington's and 96 percent of Oregon's forests had been previously logged (Kellogg 1992). Logging activities have altered the age structure of forest trees and increased forest fragmentation (i.e., forested areas occur in small, isolated patches), which may have implications for wildlife function and distribution (Smith and Collopy 2002).

In the Pacific Coastal ecoregion, the most diverse vegetative communities occur in riparian areas (Naiman 2000). Riparian areas are characterized by numerous deciduous species including willow (*Salix* sp.), cottonwood (*Populus* sp.), and alder (*Alnus* sp.). Estuaries (coastal wetlands) are often represented by tidal flats and salt marshes. Tidal flats support eelgrass (*Zostera* sp.), surfgrass (*Phyllospadix* sp.), and algae (*Enteromorpha* sp.). Pickleweed (*Salicornia virginica*) is found in tidal flats that border salt marshes. Salt marshes further upland are characterized by saltgrass (*Distichlis spicata*), jaumea (*Jaumea carnosa*), sedge (*Carex* sp.), and alkali grass (*Puccinellia pumila*) (Chappell et al. 2001).

Wetland loss and degradation has been reported throughout the analysis area. Approximately 95 percent of riparian areas in freshwater habitat surveyed in Oregon in 1988 exhibited moderate or severe degradation (Bonneville Power Administration 2001a). In the Columbia River Basin, over 50 percent of historic estuarine marshes and spruce swamps have been converted to other uses (Bonneville Power Administration 2001a). Between the 1780s and the 1980s, Washington lost 31 percent and Oregon lost 38 percent of wetlands (Dahl and Johnson 1991; Dahl 1990). The current average annual rate of wetland loss in Oregon is 546 acres per year (Oregon Wetland Joint Venture 1999). Of the four states in the analysis area, California has experienced the highest wetland loss—91 percent between the 1780s and 1980s (Dahl and Johnson 1991). Over 80 percent of the riparian vegetation along the Sacramento River (in the range of the California Central Valley Steelhead ESU) has been lost due to agriculture and urbanization (U.S. Fish and Wildlife Service 2000). Roads tend to be constructed in riparian areas, thus replacing valuable vegetation.

Coniferous forests dominated by redwood (*Sequoia sempervirens*) and Douglas-fir characterize the California Coastal Steppe ecoregion along the northern California coastline. As in Oregon and Washington, tidal flats and salt marsh estuaries occur, with similar vegetative characteristics. In drier, mountainous areas to the east (eastern Sierran Steppe ecoregion), forests may also be found at higher elevations and on western slopes (Bailey 1995).

Native vegetation of the California Dry Steppe ecoregion, primarily perennial bunchgrasses such as needlegrass (*Achnatherum* sp.), has been largely replaced by annual grasses (Veirs and Opler 2002; Bailey 1995). In river valleys, riparian areas occur on alkaline flats and are characterized by greasewood (*Sarcobatus* sp.), shadscale (*Atriplex* sp.), pickleweed (*Salicornia* sp.), and salt grass (*Distichlis spicata*) (Bailey 1995). Coastal areas south of San Francisco (California Coastal Chaparral ecoregion) are drier than northern coastal areas and support sagebrush/grassland communities (Bailey 1995). Tree species include the Monterey cypress (*Cupressus macrocarpa*) and various species of pine (*Pinus* sp.). In the California Coastal Range ecoregion, chaparral is most extensive and supports a variety of fire-adapted shrub species including chamise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos* sp.), Christmasberry (*Heteromeles arbutifolia*), California scrub oak (*Quercus dumosa*), and mountain mahogany (*Cercocarpus* sp.) (Bailey 1995). Forests in this ecoregion, called sclerophyll forests, contain various species including live oaks (*Quercus* sp.), California laurel (*Umbellularia californica*), Pacific madrone (*Arbutus menziesii*), golden chinkapin (*Chrysopsis chrysophylla*), and Pacific bayberry (*Myrica californica*) (Bailey 1995). Riparian areas are characterized by deciduous tree species.

Many native California plant communities have been severely impacted by human activities such as agriculture, logging, and urbanization. These actions have resulted in an 85 percent reduction in coastal redwood forests (Noss and Peters 1995). Other plant communities have experienced greater reductions. Native grasslands, needlegrass steeps, and southern San Joaquin Valley alkali sink scrub plant communities have all been reduced by 99 percent or more (Noss and Peters 1995).

4.10.2 Cascade-Sierra Mountains Province

The Cascade-Sierra Mountains province contains the Cascade Mixed Forest ecoregion in Washington and Oregon and the Sierran Steppe ecoregion in southern Oregon and California.

In Oregon and Washington, forests on the eastern side of the Cascades support fire-adapted species such as ponderosa pine (*Pinus ponderosa*), western larch (*Larix occidentalis*), and lodgepole pine (*Pinus contorta*). Historically, fires occurred frequently, reducing understory vegetation. Logging and fire suppression have resulted in densely forested stands and altered forest species composition. These factors have contributed to insect infestations and high-intensity fires, raising concern about forest health (Smith and Collopy 2002).

Vegetation of the Californian Cascade Mountains varies with elevation. Low elevations are characterized by chaparral and blue oak (*Quercus douglasii*), foothill pine (*Pinus sabiniana*) woodlands, grading into grasslands to the south. High elevations support ponderosa pine forests. Above about 1,500 feet, pines are intermingled with white fir in wet locations and incense-cedar (*Calocedrus decurrens*) at dry sites (Veirs and Opler 2002; Bailey 1995). Sierra Nevada foothill vegetation communities are similar to those found in the California Cascade foothills (i.e.,

chaparral and oak-pine woodlands). Low montane elevations in dry areas support ponderosa pine forests; white fir (*Abies concolor*) and giant sequoia (*Sequoiadendron giganteum*) grow in moist locations. The giant sequoia, the world's largest tree, grows naturally only in California. At high elevations in the Sierra Nevada Mountains, forests contain Jeffrey pine (*Pinus jeffreyi*) and red fir (*Abies magnifica*) (Veirs and Opler 2002; Bailey 1995). As in the Cascade Mountains, fire suppression has altered the structure and composition of forests in the Sierra Nevadas (Veirs and Opler 2002).

4.10.3 Columbia Plateau Province

The Columbia Plateau province spans three ecoregions. The Intermountain Semidesert ecoregion comprises the largest area encompassing large portions of Washington, Oregon, and Idaho. The Great Plains – Palouse Dry Steppe ecoregion covers a smaller area on the border of southern Washington and northern Idaho. The Middle Rocky Mountain Steppe ecoregion covers most of northeastern Oregon, extending somewhat into Washington and Idaho.

Sagebrush steppe, supporting species such as shadscale (*Atriplex confertifolia*), sagebrush (*Artemisia* sp.), and short grasses, characterizes the vegetation of the Intermountain Semidesert ecoregion (Bailey 1995). Riparian areas in mountainous locations in this ecoregion support sedges (*Carex* sp.) and willow (*Salix* sp.) (Bailey 1995).

A variety of species characterize the grasslands of the Great Plains - Palouse Dry Steppe ecoregion including buffalo grass (*Buchloe dactyloides*), grama (*Bouteloua* sp.), blazingstar (*Liatris* sp.), white prickly poppy (*Argemone* sp.), and the introduced Russian-thistle (tumbleweed) (*Salsola* sp.). Trees and shrubs, such as sagebrush (*Artemisia* sp.), and rabbitbrush (*Chrysothamnus* sp.), also occur in some locations in the ecoregion (Bailey 1995).

In dry mountainous areas to the east (e.g., Middle Rocky Mountain steppe ecoregion), low elevations support shrubs (sagebrush), and grasses. Ponderosa pine forests occur at low mountain elevations; high elevations are dominated by Douglas-fir, with some grand fir (*Abies grandis*) association (Bailey 1995).

Livestock grazing has had widespread impacts on native vegetation throughout the west since the 1860s. It is estimated that 70 percent of the land area in the western United States is grazed (Stohlgren 2002). Regulation of grazing began in 1934 with the passage of the Taylor Grazing Act, but effects of grazing before this legislation are still in existence, and other damaging grazing practices continue to occur (Oregon Progress Board 2000). Grazing changes the distribution and structure of native plant communities and may result in erosion, decreased water availability, and increases in weedy species (Stohlgren 2002). The non-native species cheatgrass (*Bromus tectorum*) has become widespread and out competes local flora (Stohlgren 2002; Smith and Collopy 2002). Estimates indicate that cheatgrass is the dominant species on about 16.8 million acres and has the potential to spread to 62 million more acres (Smith and Collopy 2002).

Routine road maintenance can affect the distribution of native and invasive plant species. For example, humans can inadvertently spread plants along transportation corridors if the plants' seeds become attached to mud on maintenance vehicles, or become embedded in tires, and are moved from one site to another. However, routine road maintenance activities could enhance native plant success by removal or mowing of roadside vegetation including noxious weeds, such as Himalayan blackberry or Scotch broom (ODOT 1999).

Large amounts of native vegetation have also been lost due to conversion to cropland. Agriculture has resulted in the loss of 99.9 percent of the Palouse prairie in Washington, Oregon, and Idaho (Noss et al. 1995). Ten percent of the intermountain sagebrush steppe has been converted to agriculture. The remaining area experiences livestock grazing, with 30 percent being heavily grazed (Smith and Collopy 2002). Fire suppression has also been practiced in forests and grasslands throughout the Columbia Plateau, resulting in changes in native plant and animal species distribution (Stohlgren 2002; Oregon Progress Board 2000).

4.10.4 Northern Rocky Mountains Province

The ESUs ranges that intersect with the Northern Rocky Mountains province occur only in Idaho. The majority of this physiographic province in Idaho is characterized by the Middle Rocky Mountain Steppe ecoregion. Small portions of the ESUs range in northern Idaho also fall within the Great Plains - Palouse Dry Steppe and the Northern Rocky Mountain Forest Steppe ecoregions.

The Middle Rocky Mountain steppe ecoregion is described above in the Columbia Plateau province description. This ecoregion is characterized by shrubs and grasses at low elevations and coniferous tree species in mountainous areas (Bailey 1995). As in the Columbia Plateau province, agricultural conversion, livestock grazing, and fire suppression have largely altered native plant communities in the Northern Rocky Mountain province (Smith and Collopy 2002; Stohlgren 2002). In Idaho, fire suppression is estimated to have degraded 60 to 70 percent of old-growth ponderosa pine forests (Noss et al. 1995).

Riparian vegetation in the Rocky Mountains has also been altered since historic times as a result of over-trapping of beavers. Beaver dams alter water quality and quantity, changing vegetative patterns. Reduced beaver populations have decreased the distribution of willow and moist-grass in riparian zones (Stohlgren 2002). Livestock grazing has also altered riparian vegetation. For example, "If preferred vegetation is not available, as is often the case in the overgrazed West, cattle, sheep, and goats resort to eating decreasingly palatable species, such as sagebrush, scrub oak, bear grass, manzanita, yucca, tumbleweed, and cheatgrass, eventually eating nearly anything organic, including tree bark" (Jacobs 1992). Livestock and wildlife can cause streambank alteration and erosion as well as directly impacting the vegetation by trampling the soil, compacting the soil, and exposing plant roots through hoof action (Bengetyfield and Svoboda 1998).

4.10.5 Threatened and Endangered Plant Species

Washington

Washington state contains six Federal threatened plants, three endangered, four candidates for listing, and one plant proposed for listing under the ESA. In addition, the Washington Department of Natural Resources lists 57 threatened plants that are not listed Federally or candidates for such listing (Washington Department of Fish and Wildlife 2001).

The Pacific Border province of Washington provides habitat for many rare plants including, but not limited to, queen-of-the-forest, ocean-bluff bluegrass, tall bugbane, howellia, golden paintbrush, adder's-tongue, and hairy-stemmed checkermallow (Washington Natural Heritage Program 2002).

Washington's Cascade Mountains provide habitat for many rare plants including rosy owl clover, tall bugbane, Whited's milk-vetch, Wenatchee larkspur, Chelan rockmat, Seely's silene, pale blue-eyed grass, and adder's-tongue (Washington Natural Heritage Program 2002). The Columbia Plateau province of Washington provides habitat for many rare plants including basalt daisy, Kalm's lobelia, Hoover's desert-parsley, dwarf evening-primrose, and Hoover's tauschia (Washington Natural Heritage Program 2002).

Oregon

Within the state of Oregon seven plants are Federally listed as threatened and 11 plants as endangered. In addition, the Oregon Department of Agriculture lists 28 threatened, 16 endangered, and 74 plants as candidates for listing under the state endangered species act, which are not listed Federally or proposed for Federal listing (Oregon Natural Heritage Program 2001).

Oregon's Pacific Border province provides habitat for a variety of Federal and state listed plants including Nelson's checkermallow, Willamette daisy, howellia, golden Indian paintbrush, Howell's bentgrass, tall bugbane, salt-marsh bird's-beak, white rock larkspur, and Coast Range fawn-lily (Oregon Natural Heritage Program 2001). These species occur in diverse habitats including riparian, forested, shrub-steppe, grassland, ponds, and disturbed roadsides.

The Cascade Mountains in Oregon support a number of Federal and state listed plants including, but not limited to, Suksdorf's lomatium, Barrett's penstemon, Oregon sullivantia, Howell's bentgrass, Tygh Valley milk-vetch, pumice grape-fern, Green's mariposa lily, tall bugbane, cold-water corydalis, and Oregon daisy (Oregon Natural Heritage Program 2001). Habitats for these species are diverse and may include talus slopes, riparian woods, mountain lakesides, and seeps (Hitchcock and Cronquist 1973).

Federal and state listed species found within the Columbia Plateau province of Oregon include, but are not limited to, Laurence's milk-vetch, Mulford's milk-vetch, Robinson's alium, Thompson's sandwort, slender wild cabbage, Barren Valley collomia, Crosby's buckwheat, and Cronquist's stickseed (Oregon Natural Heritage Program 2001).

Idaho

Idaho has few Federal listed species. In total, the U.S. Fish and Wildlife Service identifies only four threatened species and one candidate for Federal listing under the ESA. The Idaho Department of Fish and Game does not list any rare plants.

Federal and state listed species in Idaho's Columbia Plateau province include, but are not limited to, slick spot peppergrass, Aase's onion, Mulford's milk-vetch, Lehmi milk-vetch, meadow milk-vetch, and Davis' peppergrass (Idaho Department of Fish and Game 2002b; Idaho Native Plant Society 2002).

Federal and state listed species in Idaho's Middle Rocky Mountains province include, but are not limited to, MacFarlane's four-o'clock, Spalding's silene, Jessica's aster, Idaho douglasia, and bank monkeyflower (Idaho Department Fish and Game 2002b; Idaho Native Plant Society 2002).

California

California contains 46 Federal threatened, 134 endangered, and 1 plant proposed for Federal listing. In addition, the State Department of Agriculture lists six plants as state threatened, 40 as state endangered, and two as candidates for state listing that are not listed or proposed for listing under the Federal ESA (California Department of Fish and Game 2002).

Within California's Pacific Border province, typical Federal and state listed species include, but are not limited to, Braunton's milk-vetch, Hoover's cryptantha, adobe snakeroot, Santa Rosa Island manzanita, marsh sandwort, Trask's milk-vetch, surf thistle, Lompoc yerba santa, bensoniella, McDonald's rock cress, and Red Mountain catchfly (CalFlora 2002).

California's Sierra Mountains contain a number of Federal and state listed species, which include, but are not limited to, Ash Meadows gumweed, Greene's tuctoria, cutleaf morningglory, El Dorado bedstraw, hairy Orcutt grass, Mariposa lupine, Springville clarkia, Twisselman's buckwheat, and Keck's checkerbloom (CalFlora 2002).

4.11 Demography

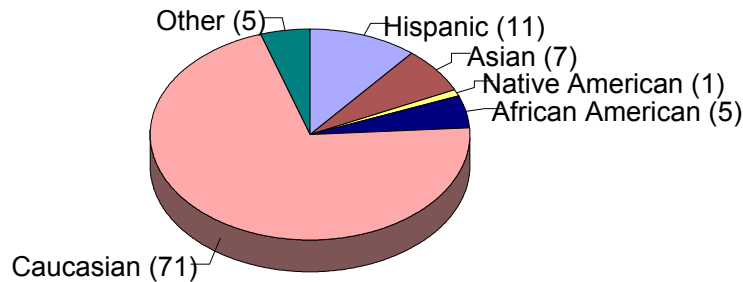
Part or all of 115 counties fall within the analysis area: 31 in Washington, 33 in Oregon, 13 in Idaho, and 38 in California. Approximately 12 million people reside within the analysis area, which represents about 27 percent of the combined populations of the four states. This population estimate for the analysis area was calculated by taking the ratio of total square miles in the 115 counties to the square miles reported to fall within the analysis area and applying that ratio to the total population in the 115 counties as reported by the U.S. Census Bureau (2001).

The population of the analysis area is culturally diverse. Native Americans, comprising about 1 percent of the population, reside throughout and retain treaty rights to fish and shellfish.

resources within the analysis area. Person of Hispanic origin comprise about 11 percent of the population of counties in the analysis area. African-American and Asian population sectors make up 5 to 7 percent of the population, respectively. At 71 percent, individuals of Caucasian background constitute the majority of the population in counties intersecting the analysis area. There are also a variety of active community and special interest based groups in the analysis area, including groups representing river transporters, irrigators, industries, commercial fishing, sport fishing, agriculture, and environmental interests.

The percentage of the total population, outside of tribal reservations, that falls within ethnic groups represented in the 115 counties is provided in Figure 9 as measured by the U. S. Census Bureau (U.S. Census Bureau 2001). The Asian population is the fastest-growing ethnic group in all regions of the nation, closely followed by the Hispanic origin population (Campbell 1996). California has the largest of the nation's Asian and Hispanic origin populations, and this is projected to continue to 2025 (Campbell 1996). Each state also has Native American populations. Washington is projected to be the fifth most populous state among Native Americans by 2025 (Campbell 1996).

Figure 9. Ethnicity in 2000 in the 11 counties that intersect the analysis area.



Source: U.S. Census Bureau 2001⁶

Population is not distributed evenly across the analysis area. Population density in the analysis area ranges from 3,501 to 15,877 people per square mile in urban areas, to 1 to 10 people per square mile in rural areas (Figure 10). Metropolitan areas with the highest population densities are located along coastal areas and waterways such as the Puget Sound, the Columbia River, and San Francisco Bay. Economic restructuring, resulting in a focus on advanced services, financial, insurance and real estate, high tech industry, has resulted in a resurgence in urban growth in some of the larger metropolitan areas, as well as communities previously dependent on resource and extractive economies (Frey and Fielding 1995).

Population growth rates for Washington, Oregon, Idaho, and California have fluctuated to a moderate degree over time, but always with an increasing trend. More recently, the western region of the United States is projected to grow at nearly twice the national average between 1995 and 2025 (Campbell 1996). The rate of growth outpaced the national average in the last decade in Washington, Oregon, and Idaho (U.S. Army Corps of Engineers 1999). California is projected to have the largest net increase in population between 1995 and 2025 with a continued increase in growth rate after 2000, which is contrary to the trend expected for most other states and will result in California containing 15 percent of the nation's population by 2025 (Campbell 1997).

⁶The accuracy of these figures is unknown, however. Census data are subject to self-reporting and processing errors, particularly when estimating populations for Native Americans and Hispanic seasonal workers.

Figure 10. 2000 County Population Densities

CLICK HERE TO OPEN FIGURE

Populations of the metropolitan areas are projected to increase substantially in the next decade. For example, the Portland, Oregon/Vancouver, Washington metropolitan area is expected to increase from what was estimated to be 1.7 million in 1997 to 2.2 million by the year 2010, an increase of almost 30 percent (Lower Columbia River Estuary Program 1999). This trend is consistent with many of the metropolitan areas within the analysis area (Table 12).

Sustaining the environment and managing the environmental effects of a rapidly growing population have become important in both rural and urban communities. Ever expanding urban development, often characterized by sprawling residential areas, building infrastructure for those areas and surrounding commercial and industrial districts, is threatening the qualities that make rural places attractive for recreation, retirement, and new business. The growing population is also increasing demands for recreational opportunities, and there is heightened interest in environmental quality in various areas (BPA 2001a).

Table 12. State population for Washington, Oregon, Idaho, and California and selected major cities in the analysis area in 2000.

STATE/CITY	POPULATION
Washington	5,894,121
Seattle	563,374
Oregon	3,421,399
Portland	529,121
Idaho	1,293,953
Lewiston	30,904
California	33,871,648
San Francisco	776,733

Source: U.S. Census Bureau 2001.

4.12 Economy

4.12.1 General Economic Trends

The regional economy has experienced considerable change over the last half-century, evolving from a natural resource-based economy to a more diverse economy, with growing technology and services sectors. The major rivers in the analysis area continue to provide a variety of resource uses, including transportation, electric power generation, recreation, and irrigation.

The harvest of anadromous fish has been an important activity, first for Native Americans and later for Euro-Americans. Native American, non-native commercial, and recreational anadromous fishing activities have all experienced declines in harvest levels over the last century. Salmon harvest continues to be important for several tribes.

The economy of the analysis area consists of the following general components, which comprise gross state products (U.S. Bureau of Economic Analysis 2001a):

- Agriculture, forestry, and fishing
- Mining
- Construction
- Manufacturing
- Transportation and public utilities
- Wholesale trade
- Retail trade
- Finance, insurance, and real estate
- Services and Tourism
- Government

Until a few decades ago, economic growth in the analysis area was fueled primarily by natural resource-based industries such as agriculture, fishing, mining, and forestry. Inexpensive hydropower was important in attracting energy-intensive industries such as aluminum production to the Pacific Northwest and California. Based on society's needs and values, choices were made to grow crops, raise cattle, build dams, harvest fish, build roads, and harvest timber, among other activities in this region (Lower Columbia River Estuary Program 1999). Many benefits and costs have been associated with this growth and change, some tangible and measurable, others intangible and unmeasurable. Numerous communities have gained from the use and management of natural resources on Federal lands, most notably of timber harvest, mining, grazing, recreation, and irrigation activities (Lower Columbia River Estuary Program 1999). Now, growth in services, government, and technology spur a large part of the economic growth of the analysis area. Many communities are experiencing a shift in economic base. Some are experiencing a decline while others are experiencing growth (Bonneville Power Administration 2001a).

To define the magnitude of the economy in the analysis area, the gross states products for all components combined are summarized in Table 13. Gross state product for a state is derived as the sum of gross state product originating in all industries in the state. As such, it is often referred to as the state counterpart of the nation's gross domestic product (U.S. Bureau of Economic Analysis 2001a).

Table 13. 1999 gross state product in current dollars (in millions of dollars).

STATE	GSP
Washington	\$209,258
Oregon	\$109,694
Idaho	\$34,025
California	\$1,229,098
Total	\$1,582,075

Source: U.S. Department of Commerce, Bureau of Economic Analysis 2001a.

For the nation, the real gross state product grew at an average annual rate of 4.0 percent from 1992 to 1999. Until recently, Oregon and Idaho were among the states with the fastest growth in real gross state product (6.8 percent and 6.6 percent, respectively) California accounted for the largest share of the nation's gross state product, but the rate of growth was only 3.9 percent between 1992 and 1999. This slow growth was attributed to longer-than-average recovery from the 1990-1991 recession and weakness in economic sectors such as Federal government, health services, and finance. Washington's average growth in gross state product (4.7 percent) reflected competing effects. Declines in lumber and wood products, transportation equipment, and printing and publishing sectors were offset by growth in business services, trade, and real estate (U.S. Bureau of Economic Analysis 2001a).

The impacts of economic changes vary throughout the analysis area. Many rural areas are located away from a developed infrastructure, and they face serious periodic economic downturns, a diminished economic base because of resource depletion, and changes in international markets and technology (BPA 2001a). An example of this is the impact of the declining role of the timber industry in the overall economy on rural communities, such as Sweet Home, Oregon, which is becoming more heavily dependent on tourism and functioning as a "bedroom community" to metropolitan areas such as Salem, Oregon.

Natural resource extraction, including fishing, agriculture, forestry, and sometimes mining is considered as a separate industry category for the assessment of the alternatives in this document. The industry is generally a small percentage of the total industrial economic base for a region. For instance, in 1992 in California, the Sacramento River region's total industry output was \$77.9 billion; agriculture, forestry, and fishing activities accounted for \$2.6 billion of this output (approximately 3 percent of the total output) (CalFed Bay Delta Program 2000). This is also true if industries are categorized by minority-owned business enterprises. The agricultural, forestry, fishing, and mining industry represented only 5 percent of American Indian- and Alaska Native-owned firms in 1997 (U.S. Census Bureau 2001). Fishing is less important in the economies of urban areas (i.e., Seattle, Spokane, Portland, Boise, San Francisco, Sacramento) than in rural areas where fewer other industries may exist (National Research Council 1996).

The gross state product in millions of dollars generated by agriculture, forestry, and fishing industries in 1999 in the four states are reported in Table 14. The gross state product for these activities comprises 2 percent of the total gross state product for all four states.

Table 14. Gross state product generated by the agriculture, forestry, and fishing industries in 1999 (in millions of dollars).

STATE	GSP (\$ million)	Total GSP (\$ million)	Percent of Total
Washington	\$4,355	\$209,258	2.1%
Oregon	\$2,898	\$109,694	2.6%
Idaho	\$1,776	\$34,025	5.2%
California	\$22,779	\$1,229,098	1.9%
Total	\$31,808	\$1,582,075	2.0%

Source: U.S. Census Bureau 2001.

As urbanization increases, new local roads are being built in former agricultural and forested lands. New interstate roads are not being built for the most part, although existing interstate roads are being widened and upgraded. States are having a difficult time funding the maintenance of existing roads as the infrastructure deteriorates over time.

Transportation infrastructure is an essential part of the economic health of the analysis area. Transportation infrastructure is important for the movement of goods and people. The primary elements are ports, interstate highways, arterial roads, rail, and airports. As stated in Oregon's Transportation Plan, "A sound multimodal transportation system is needed to support our existing economy, facilitate desired growth, reduce the costs of congestion and inefficiency, and link us together to promote success in all regions... Maintaining transportation connections among ports, manufacturing/industrial centers, agricultural regions, [tourism areas] and other key locations directly impacts the health of the [region's] economy" (Oregon Department of Transportation 2002).

4.12.2 Fishing (Commercial and Recreational)

Fishing is listed as a component of the economy under subsection 4.12.1., General Economic Trends, and is likely to be affected by the alternatives under consideration. Therefore, it is important to define the extent and magnitude of the fishing industry (commercial and recreational) within the analysis area.

Table 15 provides a summary of the value of the fishing industry as a whole in the four states. These numbers take into account all fishing-related activities.

Table 15. 2000 fishing industry data by state.

	Total Employment (full-time and part- time jobs)	Personal Income (thousands of \$)	Wage and Salary Disbursements (thousands of \$)
Washington	10,063	\$392,855	\$149,477
Oregon	3,426	\$4,4279	\$13,045
Idaho	518	\$ 3,373	\$1,018
California	7,104	\$103,386	\$ 41,843
Total	21,111	\$543,893	\$205,383

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Accounts Data, Annual State Personal Income 2001b.

Catch and income from commercial fishing vary from year to year. Decreased fish abundance in the 1990s and increased production of farmed salmon have reduced the overall present value of the commercial salmon fishing industry.

Commercial landings of salmon in the United States were 628.6 million pounds and valued at \$270.2 million in 2000. Alaska accounted for 96 percent of the total landings; Washington, 2 percent; California, Oregon, and the Great Lakes accounted for the remaining 2 percent of the catch. This level of catch was a decrease of 23 percent as compared with the catch in 1999. There has been a relatively steady downward trend in commercial landings of Pacific salmon between 1991 and 2000 (NMFS 2001). Downward trends have been occurring in other fisheries too. There was a steep decline in value of Pacific trawl fish between 1997 and 1999, while the pounds of fish landed declined to a lesser extent during these years (NMFS 2001).

Recreational fishing occurs in various parts of the analysis area, varying by seasons, abundance, and various management regimes. The value of sport harvest fluctuates according to the allowable catch, which is dictated by the abundance of fish runs and associated local harvest regulations (Bonneville Power Administration 2001). For example, the Pacific Fishery Management Council has estimated personal income effects of ocean sport fishing in Oregon and Washington in 1993 to be around \$12.5 million annually, down from \$20 million or more in the 1980s due to recent harvest restrictions to protect weak stocks of coho and chinook salmon (Bonneville Power Administration 2001). Economic value of freshwater sport fishing for anadromous fish in the early 1990s has been estimated to be about \$3 million annually and has not varied by much (Bonneville Power Administration 2001).

4.12.3 Employment/Unemployment Trends

The Bureau of Labor Statistics reports that in December 2001 the seasonally adjusted unemployment rates for the states in the analysis area are as follows (U.S. Department of Labor 2002):

•	Washington	7.4%
•	Oregon	7.8%
•	Idaho	5.5%
•	California	6.1%

The Bureau of Labor Statistics describes the unemployment and employment trends over time. Regionally, the west had the highest unemployment rate in December 2001, with Washington and Oregon having the highest state unemployment rates in the nation in December 2001. Jobless rates tended to increase nationally during 2001 after several years of decreases, with most of the unemployment resulting from downturns in the manufacturing, technology, and service industries.

4.13 Tourism and Recreation

Recreation is part of a larger sector of the economy known as tourism. Various recreational activities occur in the analysis area. They include skiing, hunting, fishing, driving for pleasure, camping, hiking, mountain climbing, horseback riding, photography, mountain biking, river rafting, snowmobiling, wind surfing, jet skiing, and sightseeing. In some parts of the analysis area, recreation is an important part of community and local economic development, supported by local planning documents for parks, open space, and recreation. Recreation is also increasingly part of the mix of uses on Federal lands. For example, in a report prepared by ECONorthwest, citing a Forest Service analysis, the national forests would contribute \$145 billion to the national economy, three quarters (\$108 billion) of which is accounted for by recreation (ECONorthwest 2001).

Another type of recreational activity is recreational fishing discussed above. These recreational activities rely on transportation, accommodation, and other service infrastructure.

4.14 Cultural Resources

Numerous historic and cultural resources exist throughout the analysis area. The National Historic Preservation Act is one of the primary laws regulating protection for such resources. In the analysis area historic resources includes Native American sites, pioneer migration sites, Spanish missions and forts, and early American settlements. Traditional tribal cultural properties are places and resources composed of both cultural sites and natural elements that are for traditional social and religious practices. For example, certain distinctive shapes in the

1 natural landscape, features in a tribe's cultural geography, habitats for culturally important food
2 and medicinal plants, traditional fisheries, sacred religious sites, and places of spiritual renewal
3 may constitute traditional tribal cultural properties (National Research Council 1996).
4

5 Salmon species are also an important cultural resource in the analysis area, dating from before
6 the earliest period of human occupation. Over 8,000 years ago, people in the general area are
7 believed to have foraged for a wide variety of food resources located in different topographic
8 zones, but particularly salmon. Since then salmon continue to be of cultural, economic,
9 recreational, and symbolic importance.
10

11 Populations of salmon have been substantially depleted in the last two centuries to
12 approximately 40 percent of their historical range. The decline in fish populations affects
13 fishery-related cultures and their social value structures. Salmon have provided social continuity
14 and heritage for many Americans, Native American tribes, and non-tribal fishing communities
15 that depend on salmon fishing (National Research Council 1996). Fishing customs are passed on
16 by sport fishers, subsistence fishers, and commercial fishers through their knowledge of historic
17 fishing spots, fishing stories, and ways of fishing.
18

19 The social values of fishery-related cultures include the values of salmon for subsistence and
20 nutritional health, their values for recreation and tourism, and their spiritual values in Native
21 American life and ceremony. Moreover, there are important symbolic links between ethnic,
22 community, and regional identities and salmon. Salmon are featured in art and song specifically
23 in the Pacific Northwest to an extent shared by few other fishes anywhere (Holm 1965, as cited
24 in National Research Council 1996).
25
26

27 **4.15 Federal Treaty and Trust Responsibilities; Tribal Rights and Interests**

28

29 This section describes the specific cultural, historical and legal context for the special
30 relationship the U.S. government has with American Indian tribes, including Federal trust
31 responsibilities, tribal rights and interests, and existing Federal relations with the tribes in the
32 analysis area. The U.S. government has a unique responsibility to Indian tribes with regard to
33 tribal rights and interests, especially the condition and status of many natural resources.
34

35 American Indians have occupied the analysis area for more than 12,000 years, but in the last two
36 centuries traditional tribal cultures and land uses have undergone significant displacement. The
37 steady growth of Euroamerican populations has caused conflicts over resource use and
38 availability, as well as pressures to change Indian cultures. The competition and conflict
39 between native and Euroamerican people in the 1800s resulted in a treaty-making period
40 between tribes and the U.S. government through the mid to late nineteenth century.
41

42 These treaties were agreements between sovereign nations, through which the U.S. government
43 recognized tribes as political entities. In the treaties, most tribes ceded lands in exchange for set-
44 asides, exclusive-use reservations, services and promises of access to traditional uses such as

1 hunting, fishing, gathering and livestock grazing. In exchange for cessation of Indian claims to
2 land, the Federal government assumed trust obligations on behalf of the tribes to protect tribal
3 assets and pre-existing rights allowing Indians to fish at usual and accustomed areas, and to hunt,
4 gather, and graze livestock on open and unclaimed lands (U.S. Corps of Engineers 1999).

5
6 In addition, presidential executive orders were signed in the late 1800s and early 1900s to
7 reserve lands for tribal use, identify certain services and identify rights for non-treaty tribes. In
8 1998 and 2000, former President Clinton signed Executive Orders on Tribal Consultation and
9 Federalism. Both orders were designed to strengthen the government-to-government
10 relationship with Indian tribes and to ensure that all executive departments and agencies consult
11 with tribes as they develop policy on issues that impact Indian communities.

12
13 There have been judicial interpretations of tribal rights and treaty language defining Federal
14 legal responsibilities. For example, a 1994 court decision involving shellfishing rights
15 determined that treaty-reserved resources were not limited to those actually harvested at treaty
16 time because the right to take any species, without limit, pre-existed the treaties (United States v.
17 Washington). Congress also adopted laws and policies that protect tribes' rights to self-
18 determination and promote the social well-being of tribes and their members. Under various
19 laws and policies therefore, Federal agencies have a responsibility to implement Federal resource
20 laws in a manner consistent with tribes' abilities to protect their members, to manage their own
21 resources, and to maintain themselves as distinct cultural and political entities.

22
23 Today's tribal cultural, social, economic, religious, and governmental interests and treaty-
24 reserved rights are dependent on landscape health, terrestrial source habitats, terrestrial and
25 aquatic species, and aquatic resources. Therefore the primary focus of the Federal trust
26 responsibility continues to be the protection of such Indian-owned assets, natural resources on
27 reservations, the treaty rights, and interests that were reserved for tribes on off-reservation lands.

28
29 For their part, tribal governments have broad social and natural resource responsibilities toward
30 their memberships and often operate under different cultural and organizational intents than
31 Federal or state agencies. Tribes have interests in reservations, Indian allotments and certain off-
32 reservation lands. However, the nature of such interests and legal rights varies. For example,
33 some tribes have a legal right to fish at all usual and accustomed places specified in treaties, for
34 both on and off reservation lands, regardless of property ownership. A list of tribal governments
35 is found in Appendix G.

36
37 Some tribes have established inter-tribal commissions to comprehensively manage resource
38 activities. The Northwest Indian Fisheries Commission and the Columbia River Inter-Tribal
39 Fish Commission are involved in fisheries management, artificial propagation of salmon
40 programs and salmon restoration plans.

41
42 As discussed under Cultural Resources (subsection 4.14) salmon has particular cultural
43 significance to American Indians in the analysis area. It is a food source, a symbol of
44 persistence and strength in a life cycle struggle, an economic industry, a prized game fish, a

1 regional political and environmental issue and a symbol of the Pacific Northwest region. For
2 many American Indians, the significance of salmon is founded in their religions, socio-cultural
3 values and identity as a community or people. Many tribes manage fisheries and salmon
4 propagation facilities to preserve their culture and provide treaty-fishing rights to their members.
5

6 7 **4.16 Environmental Justice** 8

9 Executive Order 12898 (59 Fed Reg. 7629, 1994) states that Federal agencies shall identify and
10 address, as appropriate “...disproportionately high and adverse human health or environmental
11 effects of [their] programs, policies and activities on minority populations and low-income
12 populations...”. While there are many economic, social, and cultural elements that influence the
13 viability and location of such populations and their communities, certainly the development,
14 implementation and enforcement of environmental laws, regulations and policies can have
15 impacts. Therefore, Federal agencies, including NMFS, must ensure fair treatment, equal
16 protection and meaningful involvement for minority populations and low-income populations as
17 they develop and apply the laws they are responsible for.
18

19 In the analysis area there are minority and low income populations that this Executive Order
20 could apply to, including Native American Indian tribes, and Hispanics. Appendix G lists
21 Native American Indian tribal governments. Hispanic populations traditionally were found in
22 agricultural areas drawn by jobs on farms and in food processing plants. More and more first
23 and second generation Hispanics now live and work in urban areas, where there are increasing
24 employment and business opportunities. See subsection 4.11, Demographics, for a breakdown
25 of populations.
26

27 The economic and unemployment parts of this document provide further information relevant to
28 this section.